International Journal of Older People Nursing

WILEY

International Journal of Older People Nursing

ORIGINAL ARTICLE OPEN ACCESS

Exploring the Importance and Performance Priorities of Older Adults With a User-Centred Approach to Create a Fall-Free Bathroom

Yasemin Afacan[1] | Billur Barshan[2]

[1]Department of Interior Architecture & Environmental Design and Department of Neuroscience, Bilkent University, Ankara, Türkiye | [2]Department of Electrical and Electronics Engineering, Bilkent University, Ankara, Türkiye

Correspondence: Yasemin Afacan (yasemine@bilkent.edu.tr)

Received: 31 January 2024 | **Revised:** 15 April 2024 | **Accepted:** 30 May 2024

Funding: The authors received no specific funding for this work.

Keywords: fall-free bathroom | importance–performance analysis (IPA) | older adults | sensor technology | sustainable inclusion

ABSTRACT

Background: Fall hazards in bathroom spaces constitute one of the most critical issues in the daily lives of older adults. Bathroom falls are somewhat different and constrained in nature than those in other parts of a home environment.

Objectives: This study aimed to adopt a user-centred approach to explore older adults' general bathroom needs, with a specific focus on showers and bathtubs as the designated activity area.

Methods: The authors employed an extended importance–performance analysis (IPA) with a mixed-method research design. Three hundred and eleven older adults participated in a face-to-face IPA questionnaire for the quantitative phase of the study. The authors gathered the qualitative data through open-ended questions from 59 older adults.

Results: The authors found positive correlation between older adults' attitudes towards an older-friendly bathroom and the potential for their bathrooms to be fall-free. The IPA calculations identify three key items with higher ratings in both importance and performance: The presence of appropriate artificial lighting, efficient mechanical ventilation and an accessible inside towel rail. Thematic analysis yields four themes: comfort, ease of access, error-proof design and emergency management.

Conclusions: The IPA calculations and thematic analysis confirm that older adults' rankings of importance and performance and their corresponding priority levels within the overarching themes indicate the need for these aspects to perform well and justify ongoing investments. The study concludes that addressing fall prevention requires not only designing specific solutions but also utilising appropriate technology in bathing and toileting activities.

Implications for Practice: Practitioners in geriatric and gerontological nursing, design, architecture and health care can use the importance and performance priority levels of older adults to guide the development and implementation of fall-free bathroom design. Policymakers can leverage the insights from this research to inform guidelines and regulations related to building codes, accessibility standards and healthcare policies.

1 | Introduction

There is a rapid increase in the percentage of the ageing population worldwide. Although the population aged 65 and over in Türkiye was 6,651,503 people in 2016, it increased by 24.0% in the last 5 years and reached 8,245,124 people in 2021 (Turkish Statistical Institute—Turkstat 2021a). Among the ageing population, falls are the most frequent cause of fatal and

Summary

What Does This Research Add to Existing Knowledge in Gerontology?

- This study extends beyond current knowledge in gerontology by utilising the importance–performance analysis method to quantify the priority rankings associated with creating a fall-free bathroom.
- The quantitative and qualitative findings indicate that the challenges for a fall-free bathroom are associated with a lack of facilities and unmet environmental qualities.
- This study's key contribution is that the bathroom checklists' suitability for an older-friendly design could reflect conflicts with users' perceived importance and performance levels. Thus, ageing studies should focus on the multi-disciplinary nature of bathroom design.

What Are the Implications of This New Knowledge for Nursing Care for and With Older Adults?

- The study clarifies the relationship between the most significant and the most satisfied items that should be aligned with older adults' physiological and cognitive competencies.
- Although the results are specific to Türkiye, the study contributes to the broader literature on nursing, design, ergonomics and ageing studies by providing insights into what constitutes a fall-free bathroom environment and bathing activity from the perspective of users' prioritised levels of importance and performance.
- Comfort, ease of access, error-proof design and emergency management are the four themes of the study for a fall-free bathroom, highlighting the significance of the lived experience in minimising the risk of bathroom-related fall problems.

How Could the Findings Be Used to Influence Practice, Education, Research, and Policy?

- Practitioners in geriatric and gerontological nursing, design, architecture and health care can use the research findings to guide the development and implementation of fall-free bathroom design.
- Policymakers can leverage the insights from this research to inform guidelines and regulations related to building codes, accessibility standards and healthcare policies.
- By highlighting the importance of sustainable inclusion and technology usage in fall-free bathroom design, educational curricula can be updated to emphasise these aspects, ensuring that future practitioners are equipped with the knowledge and skills to address older adults' needs effectively.

nonfatal unintentional injuries (Kenny, Romero-Ortuno, and Kumar 2017). 'Annually, around 424,000 deaths occur due to falls, 80% of which happen in medium and low-income countries' (Kimiafar et al. 2021, 116). About one-third of the older Turkish adults living at home fall at least once a year (Turkish Statistical Institute—Turkstat 2021a).

A widely adopted definition of a fall is derived from the most recent fall prevention guidelines by the American Geriatrics Society (AGS) and British Geriatrics Society (BGS). According to this definition, a fall is an unforeseen event resulting in the faller coming to rest on the ground, floor or lower level without any known loss of consciousness (Hauer et al. 2006). Falls can result in injury, hospitalisation, mortality, limited mobility and instil fear of falling (FOF) (Lee et al. 2006). Apart from physical injuries such as bone fractures and traumatic brain injuries, psychological effects such as the fear linked to falls could be equally harmful to individuals in the long run (Scheffer et al. 2008). FOF is considered a component of the postfall syndrome and has garnered significant attention in recent research (Kenny, Romero-Ortuno, and Kumar 2017). Approximately one-third of older individuals develop FOF following a fall and those afflicted with FOF experience poorer prognosis. FOF results in decreased engagement in activities of daily living, diminished self-efficacy and self-confidence, avoidance of physical activity, reduced quality of life and heightened risk of institutionalisation (Schoene et al. 2019).

Falls represent a significant concern for older adults' ability to age in place (Banks, Halstead, and LeRoux 2020). According to the European Commission Directorate-General for Employment, Social Affairs and Inclusion (2021), homes are the main setting where older adults want to age in place (Engelen, Rahmann, and de Jong 2022). Bathrooms are fundamental elements of daily home life that could make the lives of older adults possible or impossible (Moakley and Braybrooke 1987). Moreover, bathing is more challenging than any other basic task of everyday living (Fong and Feng 2018). Falls that occur in the bathroom are somewhat different and constrained in nature than falls that occur in other parts of a home environment.

Fall hazards in bathroom spaces constitute one of the most critical issues in the daily lives of older adults. Bathroom falls are more likely to occur during posture transitions between sitting and standing positions while bending the body forwards and slipping on wet surfaces. The curb of the shower or bathtub area and objects lying on the floor of a cluttered bathroom may also result in falls caused by tripping over. Space constraints inside the bathroom and transition structures between different bathroom parts (such as washbasin boundaries) are additional factors that may trigger falls (McCullagh 2006). For flooring surfaces, it is advisable to reduce contrast since patterns or features with high contrast can be interpreted as changes in elevation, thereby raising the risk of tripping and falls as well as inducing anxiety in older adults, particularly those with dementia (Engelen, Rahmann, and de Jong 2022). The need for privacy, the rigid structural requirements of bathroom materials and a low level of social acceptance for safe but unnatural designs further exacerbate the need for bathroom safety (Boge, Callewaert, and Petersen 2019; Gleisner, Rose, and Trask 2022). Previous studies explored possible bathroom retrofitting strategies to eliminate or reduce the risk of falling (Carter et al. 1997; Kivimaki et al. 2020; Lansley et al. 2004; Mauritzson et al. 2023; Sanford and Megrew 1995; Stevens, Holman, and Bennett 2001; Sveistrup et al. 2006; Tinetti et al. 1994). The toilet, bathtub, lighting and flooring are the most influential components affecting the risk of falling (Sveistrup et al. 2006). Afifi, Al-Hussein, and Bouferguene (2015) identified the best bathroom practices

for older adults to link gerontological and architectural data. Da Silva et al. (2022) identified gaps between the recommended standards and what Brazilian older adults perceive to be important. Assistive technologies for fall detection and fall impact deduction, such as radar signal processing and the use of wearable sensor technology, including motion and biomedical sensors, are developed as fall intervention strategies (Amin et al. 2016; Ölmez et al. 2024). Many studies investigate the accessibility standards for the most commonly used bathroom assistive devices, such as grab bars, shower seats, toilet risers, walking aids and transfer aids (Gleisner, Rose, and Trask 2022; Üstün 2010). There exist studies focusing on the gap between user requirements and bathroom design (Mullick 2001; Qun and Nana 2009). Lu, Luo, and Hu (2022) explored older adults' nighttime trips to the bathroom under different lighting conditions. They highlight that older adults could benefit from visual cues in the dark for safe movement. Reviewing the bathroom literature shows that contemporary bathrooms still require solutions that can improve these spaces for healthy ageing and support individual health, safety, comfort and performance (Karltun et al. 2017).

In short, there is an unmet need for fall-free, safe, comfortable and universal bathrooms. Although there is an increasing amount of research on geriatric bathrooms, fall detection systems, shower technologies and assistive devices, it should be noted that there are significant differences among shower design guidelines, bathroom standards and real-world experiences of older adults whose satisfaction and importance needs and interests are diversified. 'There may be a difference between the quality as set out in guidance documents and interpreted by designers and constructors and the user's perception of quality of the built space based on direct experience of using the facility' (Da Silva et al. 2022, 1). Developing user-centred research tools that help understand older adults' bathroom interaction patterns is an increasingly urgent challenge. 'The interaction one has with their home environment is critical in shaping their health behaviors' (Barton et al. 2023, 2). Therefore, there is an inevitable need to focus on older adults' bathroom priority perspective, to gain in-depth data on areas of immediate attention and to create older-friendly and fall-free bathrooms that match well with the needs of older adults. This study aimed to adopt a user-centred approach to explore the needs of older adults regarding bathrooms in general, with a specific focus on showers and bathtubs as the designated activity area. This aim involves ensuring that bathrooms meet the importance requirements to prevent falls among older adults while also maximising their overall bathroom performance, which is vital to healthy ageing. The objectives of the study are as follows: (1) to analyse correlations between the older adults' attitude towards an older-friendly bathroom and their self-rated overall bathroom activities performance, (2) to identify importance–performance priority levels of a fall-free bathroom and (3) to extract the overarching themes of the corresponding priority levels.

2 | Methods

2.1 | Participants and the Setting

A total of 311 older adults voluntarily enrolled in the study. The participants belonged to middle-income levels and resided in the predominant type of dwelling in Türkiye: apartment-type buildings. Considering that lower socioeconomic status is linked to an increased risk of falling (Kim, Choi, and Xiong 2020), this study opted for participants from the middle-income bracket. We made this choice to mitigate biases stemming from income disparities, given that most Turkish older adults belong to this income level, according to the poverty report of the Turkish Statistical Institute—Turkstat (2021a). The authors employed a convenience sampling method to recruit participants from the largest district of Ankara and chose the participants among mentally healthy older residents aged 65 and over who had experienced a fall at home within the last 2 years based on their records in their Family Health Centers of this district. Bilkent University Institutional Ethical Review Committee approved the study (the approval number: 2022_06_29_01). Before the enrolment, we informed the participants about the purpose of the study and clearly defined confidentiality and withdrawal at any time. Then, the participants signed an informed consent form.

2.2 | Data Collection

The study followed a mixed-method research design approach. For the quantitative process, we selected to use a face-to-face bathroom self-assessment questionnaire for data collection. The questionnaire was composed of questions in three categories: (1) demographic questions (age, gender, cohabitation status and dependence on daily living activities), (2) self-rated performance of their daily bathroom activities on the basis of the items of Barthel Index (Mahoney and Barthel 1965) and (3) importance–performance analysis (IPA) questions. The IPA questions adapted their items from the attributes of the following five standards on bathroom design: Accessibility to Buildings, Furniture, Space, and Urban Equipment 2015 (Brazil), Americans with Disabilities Act 2010 (USA), Design of an Accessible and Inclusive Built Environment 2018 (England), National Building Code of Canada 2015 (Canada) and Code on Barrier-Free Accessibility in Buildings 2019 (Singapore). The reason why we chose these standards is that they provide the most commonly referred guidelines in the design literature to create accessible and sustainable built environments for all people (Clarkson and Coleman 2015; Da Silva et al. 2022; Dong and Clarkson 2005; Hassanain et al. 2019; Mace 1998; Mullick, Preiser, and Ostroff 2001). Moreover, Türkiye does not have national guidance on bathroom design. There is only one standard, TS 9111 Turkish Standard (2011), which includes general guidelines for the accessibility requirements in buildings for people with disabilities and mobility constraints. Da Silva et al. (2022) listed the bathroom attributes concerning these five standards in their recent study of perceived attributes and dimensions of accessibility in adapted bathrooms. These standards group the bathroom attributes under the following five dimensions: Environment, washbasin, sanitary basin, door and shower area.

While adapting the IPA questions of the bathroom self-assessment questionnaire, we conducted a three-step process. In the first step, we initially took all the environment dimensions' attributes (eight items) and all the shower area dimensions' attributes (10 items) from the above-listed standards (Da Silva et al. 2022). We eliminated the attributes of the washbasin, sanitary basin and door dimensions because we chose the shower/bathtub as the most critical bathroom environment for falls for the framework of the study because of the complexity

of the tasks that take place in that area. In the second step, to ensure the ergonomic basis of each item and the content validity of the questionnaire regarding standardisation in the Turkish context, 10 Turkish design practitioners assessed these 18 items based on the Turkish standards TS 9111 (2011) and Turkish accessibility guide developed by Ministry of Family, Labor and Social Services of the Republic of Türkiye. The experts are five architects and five interior architects: (1) having universal design knowledge, (2) with at least 15 years of practice experience in different scale design projects and (3) always using and referring to TS9111 standards and the recent Turkish accessibility guide (2020).

Regarding the empirical analysis of the reliability of the IPA questions, each architect and interior architect anonymously and individually assessed the suitability of each item according to Turkish standards and the Ministry's accessibility guidance and proposed additional items for the environment and shower area dimensions. In the third step, each architect and interior architect anonymously and individually evaluated the added items by scoring them according to the seven principles of Universal Design (Story 1998), which are guiding principles for designing and evaluating services, products and buildings for all people regardless of age, size and ability. This evaluation suggested a numerical value calculated on the presence of each universal design principle for each recommended item (none = 0; available = 1). Thus, each item regarding each universal design principle has a minimum score of 0 and a maximum score of 7. We eliminated items scoring 3 or less (not corresponding to more than half of the principles). At the end of the assessment, only two additional items scored above 3.

Following this step, the IPA questions resulted in 20 items (Table 1). Before initiating data collection, we conducted a pilot study. Moreover, the authors measured the internal consistency of each dimension with Cronbach's alpha (α) and illustrated this in Table 3. We further organised the IPA questions into two sets. The first set included 20 items, 8 for the bathroom and 12 for the shower/bathtub area. In the first set, we asked the participants to rate their importance level for each item on a 5-point Likert scale, from 1 (least important) to 5 (most important), to identify the importance rankings of bathroom and shower/bathtub area items for fall-free design in general. The second set included the same 20 items, which asked the participants to rate their performance level in their bathrooms for each item in terms of being fall-free. We used the same 5-point scale for the second set, from 1 (very dissatisfied) to 5 (very satisfied).

For the qualitative process, the authors extended the IPA approach by incorporating the three following open-ended questions: (Q1) What is your most desired bathroom item to prevent falls in your current bathroom? (Q2) What challenges exist in your current bathroom, causing you to feel unsafe and insecure regarding falls? (Q3) What are your suggestions about the fall prevention and/or detection technologies used in bathroom environments and showers/bathtubs? We conducted the qualitative part with 59 of the 311 survey participants. This part was crucial in deeply analysing the priority levels on the basis of the participants' comments, suggestions and more detailed descriptions of rankings. Twenty-six participants gave

TABLE 1 | List of the two set IPA questions.

Item no	Item set	Attribute
		Bathroom environment
Item 1	IMP1/PRF1	The presence of appropriate artificial lighting
Item 2	IMP2/PRF2	The presence of efficient mechanical ventilation
Item 3	IMP3/PRF3	The presence of an easily openable window
Item 4	IMP4/PRF4	The presence of slip-resistant floor material
Item 5	IMP5/PRF5	The presence of an accessible emergency alarm system
Item 6	IMP6/PRF6	The presence of appropriate size and space of the environment
Item 7	IMP7/PRF7	The presence of appropriate size and space of the bathing area
Item 8	IMP8/PRF8	The presence of user-friendly electrical sockets and switches
		Shower/Bathtub
Item 9	IMP9/PRF9	The presence of user-friendly multiple shower heads positioned at adjustable heights
Item 10	IMP10/PRF10	The presence of an accessible storage niche inside the shower/bathtub
Item 11	IMP11/PRF11	The presence of an accessible inside towel rail
Item 12	IMP12/PRF12	The presence of accessible wall-mounted grab bars
Item 13	IMP13/PRF13	The presence of a safe built-in shower seat
Item 14	IMP14/PRF14	The presence of a proper type and model shower/bathtub cabin
Item 15	IMP15/PRF15	The presence of a curbless or low curb threshold access
Item 16	IMP16/PRF16	The presence of an ideal water temperature
Item 17	IMP17/PRF17	The presence of a safe shower/bathtub curtain
Item 18	IMP18/PRF18	The presence of a low-effort sliding shower/bathtub door

(Continues)

TABLE 1 | (Continued)

Item no	Item set	Attribute
Item 19	IMP19/PRF19	The presence of a smart fall prevention mat inside the shower/bathtub
Item 20	IMP20/PRF20	The presence of smart shower/bathtub slippers for fall prevention

permission for their bathrooms to be photographed, further to link the gerontological data with the visual architectural information.

We collected the quantitative and qualitative data in the participants' living environments. Engineering and design graduate students who had qualitative and quantitative data collection knowledge read the questions to the participants and noted their responses.

2.3 | Data Analysis

The study conducted statistical analyses and IPA calculations. The authors performed statistical analyses using JASP 0.17.1, an open-source, flexible and reliable statistics programme supported by the University of Amsterdam (JASP 2022). We employed descriptive statistics to present the participants' demographics as mean values and standard deviations (SDs), using frequencies and percentages to illustrate the proportions of dependence in each daily living activity. We conducted Pearson's correlation tests to analyse the significant relationships between the self-rated performance of the daily bathroom activities and their attitude towards an older-friendly bathroom. The study also conducted correlation analyses to investigate relationships between participants' bathroom potential of being fall-free and the highest rated IPA items for a fall-free bathroom. The authors performed the independent samples *t*-test to identify significantly different rated IPA items between older adults' genders and conducted one-way ANOVA to compare the mean difference scores among the participants' age groups. We set the significance level for the statistical analyses to $p < 0.05$.

The authors performed IPA calculations by constructing a two-dimensional priority graph of importance and performance ratings. Martilla and James introduced IPA in 1977, and it is used today as a methodological tool in many studies to identify a set of user priorities to meet changing and conflicting needs and demands (Martilla and James 1977; Afacan 2019; Chen, Murphy, and Knecht 2016; DeSouza and Chard 2022; Insch 2010; Skok, Kophamel, and Richardson 2001; Taoz and Afacan 2020). Figure 1 illustrates the IPA graph and its four quadrants. First, we calculated the cut-off points among the quadrants on the basis of the overall mean values of importance and performance items. Each quadrant (Q) refers to the following key qualities: $Q1$: keep up the good work; $Q2$: concentrate here; $Q3$: low priority; and $Q4$: potential overkill. Then, we depicted the importance items on the x-axis and displayed the performance items on the y-axis on the basis of their mean values. There were no ceiling and floor effects (no items with mean values ≥4.5; no items with mean values ≤1.5); therefore, we did not eliminate any of the items from the IPA calculations.

We analysed the qualitative data by using thematic analysis. Thematic analysis is an analytical technique that comprises the following six phases: Familiarising with the data, generating the codes, searching for themes, reviewing the themes by referring to a specific pattern, defining the theme names and conducting the final analysis of the extracted themes (Braun and Clarke 2006). This study followed the six phases outlined in Braun and Clarke's (2006) qualitative data analysis study. The first author completed the first four phases by (1) re-reading the responses for each question and noting down initial ideas, (2) systematically generating codes for the ideas, (3) searching for the themes to group the codes under the themes and (4) reviewing and refining the themes. The study defined the code as a short phrase that 'symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data' (Saldana 2016, 4). The second author completed the last two phases by (5) further reviewing the coded data under the themes and naming themes and (6) conducting the final analysis of the theme extraction.

3 | Results

3.1 | Demographic Characteristics

The authors collected 311 responses. However, due to missing answers to questions and inconsistent replies, the findings resulted in a sample of 295 older adults (125 female and 170 male) aged 65–97 (mean = 75.292; SD = 6.483). On the basis of the United Nations' (2019) criteria, the study classified the participants under the following ageing categories: Young–old (age 65–74), old (age 75–84) and old–old (age 85 and over). There were only 21 participants under the old–old category. The rest of the participants were equally distributed under the young–old and old categories. Most participants were married (70.847%) and living with a spouse (62.373%). Only 11 participants were living with a caregiver. Most of the participants obtained a university degree. According to the dependence proportions of the participants, more than half of the participants were independent in all their daily activities. The lowest independence percentage was found in the cooking activity (51.864%). This may be attributed to the tradition of older Turkish men not cooking and instead relying on women to prepare meals for them. In contrast, the eating–drinking activity was the most independent activity performed without assistance by 200 participants. Table 2 presents the descriptive statistics of the participants' demographic characteristics.

3.2 | Relationship Between Self-Rated Performance and Attitude Towards an Older-Friendly Bathroom

The study found a trending significant positive correlation between the participants' attitude towards an older-friendly bathroom and their self-rated overall bathroom activities performance

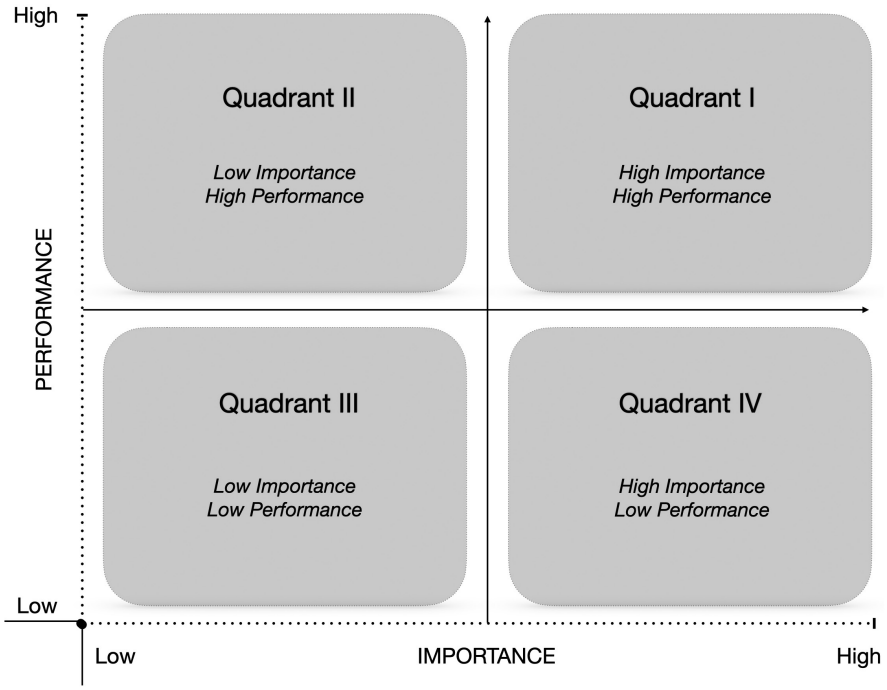

FIGURE 1 | IPA graph and its four quadrants.

(Pearson's $r = 0.112$; 95% CI [−0.002, 0.223]; $p = 0.055$). The correlation between attitude and self-rated performance was weak, which could provide insights into how these two variables are related and might help make predictions or informed decisions about older-friendly bathrooms. There was also a weak positive correlation between participants' attitude towards an older-friendly bathroom and their bathroom's potential of being fall-free (Pearson's $r = 0.124$; 95% CI [0.235, 0.010]; $p = 0.034$). To compare the importance of an older-friendly bathroom based on gender, the authors conducted an independent samples *t*-test. The findings revealed no statistically significant difference between female and male respondents ($t = -0.210$; $p = 0.834$).

To compare differences in the participants' importance level of an older-friendly bathroom among the three categories of age, the study conducted a one-way ANOVA between groups. The findings showed significant differences among aged groups ($F = 5.039$; $p < 0.001$). Furthermore, the authors performed the Tukey Honest Significant Difference (HSD) test for post hoc analysis to identify where exactly the difference lay. The Tukey (HSD) analysis showed that the old–old group differed significantly from the young–old (MD = 0.741; SE = 0.160; $t = 4.627$; $p < 0.001$) and old groups (MD = 0.609; SE = 0.161; $t = 3.795$; $p < 0.001$). However, there was no statistically significant difference between the young–old group and the old group regarding their importance level of an older-friendly bathroom (MD = 0.131; SE = 0.090; $t = 1.458$; $p = 0.313$). The study conducted a one-way ANOVA between the three groups to compare differences in the participants' importance level of an older-friendly bathroom among their education levels and functional abilities. The findings revealed no statistically significant differences among their education levels ($F = 0.291$; $p = 0.623$) and functional abilities ($F = 0.339$; $p = 0.748$).

The study analysed the statistical correlations between the participants' bathroom potential of being fall-free and the highest ranked importance and performance item. 'Item 1 (IMP1)—The presence of appropriate artificial lighting' (mean = 4.403; SD = 0.922). The highest ranked performance item was 'Item 7 (PRF7)—The presence of appropriate size and space of the bathing area' (mean = 4.346; SD = 0.496). The findings showed no statistically significant correlation between the participants' bathroom's potential to be fall-free and the highest ranked importance item (Pearson's $r = -0.075$; $p = 0.200$) as well as with the highest ranked performance item (Pearson's $r = -0.058$; $p = 0.321$).

3.3 | Importance–Performance Priority Levels

The study calculated IPA ratings for each item. We present the mean values of importance and performance ranking, *t*-test results and IPA quadrants in Table 3. The *t*-test results showed that except for two items, 'the presence of user-friendly electrical sockets and switches' and 'the presence of a safe shower/bathtub curtain', there were statistically significant differences between all other importance and performance items. We constructed the IPA graph with its four quadrants (Figure 2) and calculated the cut-off points of the graph based on the overall mean value of the importance ratings (mean = 4.058; SD = 0.781) and the performance rating (mean = 3.297; SD = 0.762).

The results from the IPA calculations revealed three items in Quadrant 1: 'Item 1—The presence of appropriate artificial lighting'; 'Item 2—The presence of efficient mechanical ventilation'; and 'Item 11—The presence of an accessible inside towel rail'. These items have higher ratings than the overall average ratings in importance and performance; therefore, they are considered to perform well, and continuing investments are needed. Interestingly, half of the items were calculated to be in Quadrant 2: 'Item 3—The presence of an easily openable window'; 'Item 6—The presence of appropriate size

TABLE 2 | Descriptive statistics of the participants' demographic characteristics.

Demographic information	Categories	Frequency	Total	Percentage
Gender	Female	125	295	42.373
	Male	170		57.627
Age	65–74	142	295	48.136
	75–84	132		44.746
	85+	21		7.119
Marital status	Single	14	295	4.746
	Married	209		70.847
	Divorced	12		4.068
	Widowed	60		20.339
Education level	University	220	295	74.576
	High school	75		25.424
Cohabitation status	Alone	31	295	10.508
	With a spouse	184		62.373
	With children	52		17.627
	With a caregiver	11		3.729
	With grandchildren	17		5.763
Dependence			295	
Eating–drinking	Dependent	53		17.966
	Partly dependent	42		14.237
	Independent	200		67.797
Personal hygiene	Dependent	63		21.356
	Partly dependent	46		15.593
	Independent	186		63.051
Going to toilet	Dependent	62		21.017
	Partly dependent	42		14.237
	Independent	191		64.746
Circulating between the rooms	Dependent	57		19.322
	Partly dependent	26		8.814
	Independent	212		64.746
Dressing	Dependent	62		21.017
	Partly dependent	47		15.932
	Independent	186		63.051
Using below cabinets	Dependent	78		26.441
	Partly dependent	46		15.593
	Independent	171		57.966
Using above cabinets	Dependent	74		25.085
	Partly dependent	34		11.525
	Independent	187		63.390

(Continues)

TABLE 2 | (Continued)

Demographic information	Categories	Frequency	Total	Percentage
Cooking	Dependent	99		33.559
	Partly dependent	43		14.576
	Independent	153		51.864
Ascending and descending the stairs	Dependent	78		26.441
	Partly dependent	40		13.559
	Independent	177		60.000

and space of the environment'; 'Item 7—The presence of appropriate size and space of the bathing area'; 'Item 8—The presence of user-friendly electrical sockets and switches'; 'Item 9—The presence of user-friendly multiple shower heads positioned at adjustable heights'; 'Item 10—The presence of an accessible storage niche inside the shower/bathtub'; 'Item 14—The presence of a proper type and model shower/bathtub cabin'; 'Item 17—The presence of a safe shower/bathtub curtain'; 'Item 18—The presence of a low-effort sliding shower/bathtub door'; and 'Item 20—The presence of smart shower/bathtub slippers for fall prevention'. These items were in high performance but of low importance. The findings in Quadrant 2 were surprising, given the emphasis of older-friendly bathroom literature on home accessibility and usability. However, in this study, regarding the fall-free nature of bathrooms, the performance placed on these items was higher than their importance. This indicated that the resources committed to these items should be better employed for the other highly ranked items. It is interesting to note that there was only one item depicted in Quadrant 3: 'Item 5—The presence of an accessible emergency alarm system'. This item was considered low priority, so intervening here did not increase the importance. This item in this quadrant had a lower rating than the overall average ratings in importance and performance.

There were six items in Quadrant 4: 'Item 12—The presence of accessible wall-mounted grab bars'; 'Item 13—The presence of a safe built-in shower seat'; 'Item 15—The presence of a curbless or low curb threshold access'; 'Item 16—The presence of an ideal water temperature'; and 'Item 19—The presence of a smart fall prevention mat inside the shower/bathtub'. These items in Quadrant 4 were a primary concern for improvement. It was necessary to address the weaknesses critically and identify the improvement correctly for these items for appropriate resource allocation. Researchers working on fall-free bathrooms need to concentrate here to take the impacts of these items on fall prevention seriously and make better strategic bathroom planning decisions.

3.4 | Overarching Themes of a Fall-Free Bathroom

A total of 59 participants (25 female and 34 male, mean age = 75.24, SD = 6.788) took part in the qualitative process. The qualitative part took place right after the questionnaire, which lasted approximately 45–55 min for each participant. The interviewers asked the three following questions in respective order and recorded the interview: (Q1) What is your most desired bathroom item to prevent falls in your current bathroom? (Q2) What challenges exist in your current bathroom, causing you to feel unsafe and insecure regarding falls? (Q3) What are your suggestions about the fall prevention and/or detection technologies used in bathroom environments and showers/bathtubs? Twenty-six participants among 59 permitted their bathrooms to be photographed. We took one photograph of each bathroom, resulting in a total of 26 photographs. Four themes emerged from the responses: Theme 1—comfort; Theme 2—ease of access; Theme 3—error-proof design; and Theme 4—emergency management. Figure 3 illustrates the tabulated version of the thematic map of the themes, the associated bathroom items and the number of participants who mentioned these themes.

3.4.1 | Theme 1: Comfort

A common desire raised by most participants (42 participants) was a comfortable bathroom environment. Comfort was defined in multiple ways. Although most of these participants (37 participants) highlighted the role of a comfortable seat while taking a shower, four participants addressed their demand for visual comfort. They pointed out that an openable window was not only necessary for natural light but also necessary for ventilation and reducing humidity. One participant emphasised that a well-lit, ventilated bathroom improves visibility and prevents falls. Another participant commented on the role of an openable window for the thermal comfort of a fall-free bathroom. Ten participants interpreted comfort as a clear floor area that allows one to walk, turn, sit and use the toilet comfortably. Another participant's most desired bathroom item for fall prevention was a built-in bench in the shower area. Participants identifying their most desired bathroom theme as comfort complained about the lack of design practices that give little attention to the design qualities of wet spaces. In Türkiye, bathrooms are often small and dark spaces planned based on the left-over areas in spatial layouts. This problem requires improving the indoor air quality of bathrooms and revising planning policies to provide bathing areas with built-in seating for all people regardless of age, ability and size.

> The size and layout of my bathroom do not allow me a comfortable private space. I would like to have a clear floor area in front of the shower.
>
> —Participant #45 (female, 77 years old; see Figure 4a)

TABLE 3 | Mean values of importance and performance ranking, the Cronbach's alpha (α) values, *t*-test results and IPA quadrants.

Item no	Items	Importance, mean (SD)	Performance, mean (SD)	*t*	*p*	IPA quadrant
		Bathroom environment				
		Cronbach's $\alpha = 0.907$				
Item 1	The presence of appropriate artificial lighting	4.403 (0.922)	3.414 (0.920)	17.769	<0.001	1
Item 2	The presence of efficient mechanical ventilation	4.264 (1.027)	3.729 (1.213)	8.257	<0.001	1
Item 3	The presence of an easily openable window	3.989 (1.166)	3.539 (1.113)	5.707	<0.001	2
Item 4	The presence of slip-resistant floor material	4.244 (0.961)	2.824 (1.121)	17.802	<0.001	4
Item 5	The presence of an accessible emergency alarm system	3.858 (1.089)	2.871 (1.379)	9.849	<0.001	3
Item 6	The presence of appropriate size and space of the environment	4.007 (1.089)	3.458 (1.128)	6.227	<0.001	2
Item 7	The presence of appropriate size and space of the bathing area	3.997 (1.195)	4.346 (0.496)	−5.165	<0.001	2
Item 8	The presence of user-friendly electrical sockets and switches	3.576 (0.924)	3.583 (1.190)	−0.088	0.930	2
		Shower/Bathtub				
		Cronbach's $\alpha = 0.895$				
Item 9	The presence of user-friendly multiple shower heads positioned at adjustable heights	3.715 (1.199)	3.366 (1.202)	3.971	<0.001	2
Item 10	The presence of an accessible storage niche inside the shower/bathtub	3.993 (0.967)	3.576 (1.307)	4.631	<0.001	2
Item 11	The presence of an accessible inside towel rail	4.166 (1.023)	3.485 (1.198)	7.78	<0.001	1
Item 12	The presence of accessible wall-mounted grab bars	4.234 (1.091)	3.115 (1.514)	10.720	<0.001	4
Item 13	The presence of a safe built-in shower seat	4.200 (1.113)	2.658 (1.211)	16.786	<0.001	4
Item 14	The presence of a proper type and model shower/bathtub cabin	3.783 (1.294)	3.308 (1.389)	5.395	<0.001	2
Item 15	The presence of a curbless or low curb threshold access	4.183 (1.045)	2.441 (0.915)	21.371	<0.001	4
Item 16	The presence of an ideal water temperature	4.054 (1.248)	3.237 (0.580)	9.410	<0.001	4
Item 17	The presence of a safe shower/bathtub curtain	3.661 (1.260)	3.617 (1.445)	0.444	0.657	2
Item 18	The presence of a low-effort sliding shower/bathtub door	3.915 (1.121)	3.505 (1.473)	4.330	<0.001	2

(Continues)

TABLE 3 | (Continued)

Item no	Items	Importance, mean (SD)	Performance, mean (SD)	*t*	*p*	IPA quadrant
Item 19	The presence of a smart fall prevention mat inside the shower/bathtub	4.359 (1.092)	2.342 (0.857)	25.032	<0.001	4
Item 20	The presence of smart shower/bathtub slippers for fall prevention	3.976 (1.269)	3.536 (1.442)	4.590	<0.001	2
			Overall Cronbach's α = 0.912			

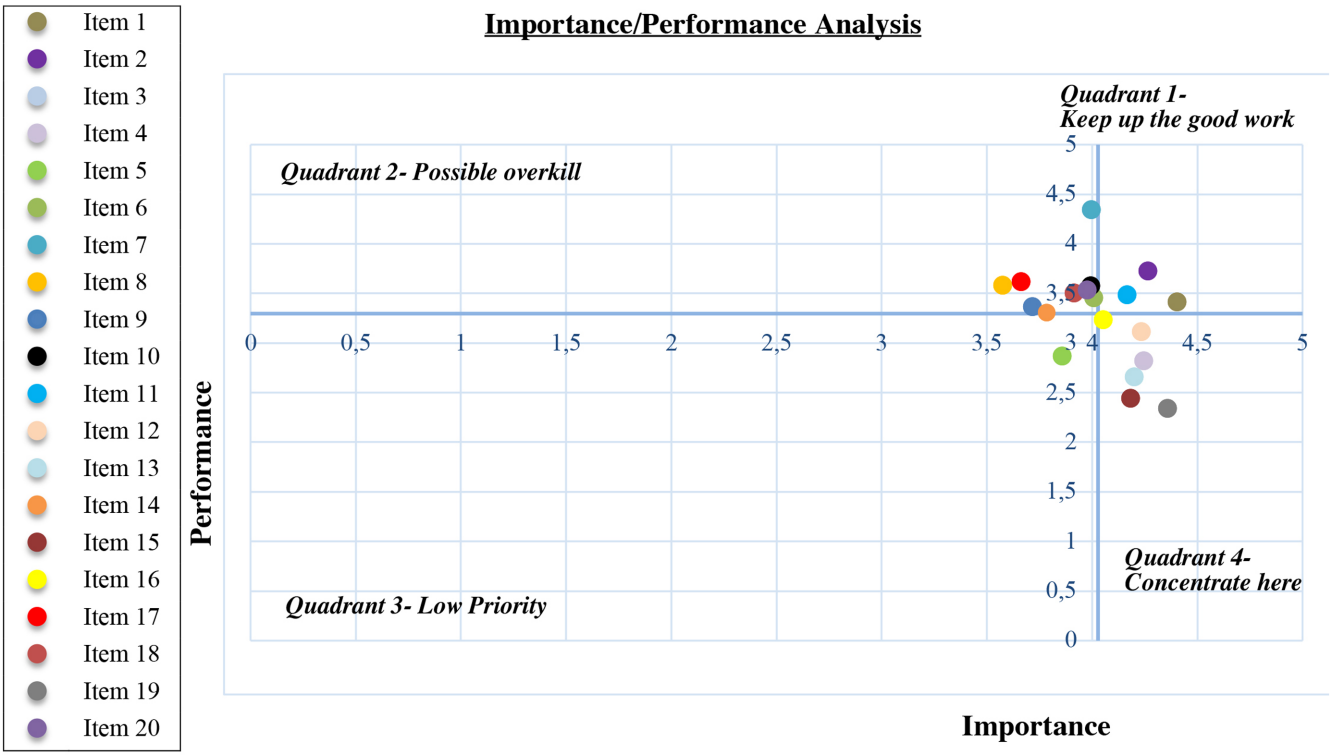

FIGURE 2 | Importance and performance rankings depicted in the four quadrants of the IPA graph.

> I want to shower comfortably while sitting on a built-in bench.
>
> —Participant #4 (male, 81 years old; see Figure 4b)

> Air circulation is critical. I wish to have proper ventilation because the moisture on the floor is a fall risk. An openable window could help reduce the moisture.
>
> —Participant #17 (male, 78 years old; see Figure 4c)

3.4.2 | Theme 2: Ease of Access

Accessibility and usability are the two inevitable terms discussed by many ageing studies, disability research and barrier-free design practices. Although buildings and spaces are planned, designed and constructed based on technical requirements and guidelines, accessibility should go beyond a checklist requirement. This challenge was more evident when the participants explained their perceived bathroom accessibility. Ease of access involves low physical effort, which means ensuring comfortable usage with minimum fatigue (O Shea et al. 2016). Three participants pointed out the quality of interaction between their bathing activity and the bathtub. In Türkiye, there is a lack of postoccupancy studies because of financial issues. Evaluating the quality of accessibility in bathrooms could serve as a basis for future research related to improvements, modifications and developments for fall-free bathrooms. Twenty-four participants highlighted that a curbless shower increased their satisfaction with the bathing activity. Another three participants stated that their bathtub is accessible but not effectively, efficiently and satisfactorily. Two participants noted that bathroom accessibility is multifaceted and dependent on the quality of safety, which requires simultaneous analysis of all bathroom items. Thus, the access quality perceived by the user should be analysed in depth

Themes / Bathroom items	Built-in seat	An openable window	Efficient lighting	Effective ventilation	A clear floor area	Curbless shower	Slip-resistant floor material	Grab bars	Radar Systems	Wearables	Smart fall prevention mat
Theme 1: Comfort	37	4	5	22	10						
Theme 2: Ease of access					3	24					
Theme 3: Error-proof design							32	28			
Theme 4: Emergency Management									10	20	15

FIGURE 3 | Themes and associated bathroom items, along with the number of participants who mentioned these themes.

to create a fall-free bathroom environment. The challenge for all researchers who work in this area is to respond to the question of what defines access as ease of access.

> I prefer an accessible low-curb bathtub to a curbless shower. Although both could be listed under accessible bathrooms, I do not feel safe with showers due to the risk of flooding.
>
> —Participant #1 (female, 72 years old; see Figure 5a)

> My shower is easily accessible. However, the floor material is not slip-resistant, which causes me to feel unsafe and insecure regarding falls.
>
> —Participant #22 (female, 79 years old; see Figure 5b)

3.4.3 | Theme 3: Error-Proof Design

According to all study participants, safety was critical for fall prevention. Participants described their understanding of the safety of a fall-free bathroom as an error-proof design in this theme. Error-proof design means minimising the negative consequences of accidental events such as falls. More than half of the participants highlighted that a bathroom environment should be designed so that older adults can respond to hazards quickly and ensure safety during emergencies. Thirty-two respondents acknowledged the essential role of slip-resistant floor material in reducing the risk of falls and injuries. Installing nonslip flooring will take a little additional money and time investment and will pay off in the future. Twenty-eight participants highlighted the role of grab bars. As commented, grab bars help create a fall-free bathroom space that works for everyone. They are not only critical in preventing falls but also may help prevent falls when a fall is in progress, as well as minimise injuries after a fall. Thus, grab bars mounted to reinforced concrete walls minimise the risks of prefall, fall and postfall injuries. Ten participants complained about the cold institutional look of the grab bars. Thirteen participants suggested the use of colour and design of bars as toilet paper or towel holders. There is a need for better planning, design and construction of assistive devices for better safety (Kivimaki et al. 2020; Mauritzson et al. 2023).

> Although I know that having grab bars could make me feel safer while showering and toileting, I hate them. They are bulky.
>
> —Participant #51 (male, 88 years old)

> There should be different color and design options for grab bars in the market.
>
> —Participant #7 (male, 85 years old)

3.4.4 | Theme 4: Emergency Management

The most discussed issue during the interviews was conveniently accessible technology to detect falls. Most participants (30 participants) had difficulty recalling the memories associated with their falls. Only some (10 participants) were able to describe their memories and highlighted two challenges: Feeling the fall and getting up by themselves despite the fall. Thus, 10 participants commented on using radar signals for a prompt fall detection system. Twenty participants acknowledged the necessity of a body-worn device rather than a push button or an alarm system, which cognitively impaired older adults could not intuitively use. This statement may explain the reason for the low importance ranking of 'Item 5—The presence of an accessible emergency alarm system.' However, 15 participants were concerned about the shortcomings of such wearables and suggested smart fall prevention mats. Seven participants emphasised a pre-impact fall detection system as an emergency management strategy for a fall-free bathroom. One participant shared thoughts on systems designed to swiftly deploy when detecting a fall, offering cushioning and protection upon impact, especially for sensitive areas such as the hips. The participant illustrated this idea with the example of an inflatable airbag system, highlighting its

FIGURE 4 | Exemplary close-up shower photos taken from the Participants' bathrooms by the Interviewer: (a) from the Participant #45's bathroom, (b) from the Participant #4's bathroom and (c) from the Participant #17's bathroom.

effectiveness in minimising the impact of falls and protecting the hips.

> If my shower had a smart technology to manage emergencies, it would avoid placing a major burden on my children.
>
> —Participant #5 (male, 85 years old)

> I was terrified. You could not be careful while bathing. The floor is soapy. There should be information technology with sensors, such as shower slippers, to monitor movement patterns, localize abnormal events, and inform my son if any fall-related injury occurs.
>
> —Participant #13 (female, 89 years old)

FIGURE 5 | Exemplary close-up photographs taken from the participants' bathrooms by the interviewer: (a) bathtub photograph and (b) floor material photograph.

> While bathing, a wearable sensor could be easily broken. I don't want to use it. However, I don't want to use a push button either. My last fall was my fault, but when I hit the ground, I felt dizzy and could not use any buttons for a while. An emergency system should be capable of informing my relatives automatically.
>
> —Participant #58 (female, 72 years old)

4 | Discussion

This study proposed a user-centred approach for fall-free bathrooms using a mixed-method research design. It aimed to identify older adults' importance and performance rankings and correlate their priority levels with the overarching themes of a fall-free bathroom design. Findings highlighted the adoption of sustainable inclusion along with technology usage. A key result from this study is that the suitability of the bathroom checklists

for an older-friendly design could reflect conflicts with users' perceived importance and performance levels (Watchorn et al. 2022).

Results of the study hold potential for generalisation to Turkish older adults with middle-income levels, as the bathroom characteristics examined in the study and included in the photographs align with the typical physical conditions found in apartments, which represent the most prevalent housing type in Türkiye (Turkish Statistical Institute—Turkstat 2021b). The results of this mixed-method study could be discussed from the two aspects: (1) supporting facilities and (2) indoor environmental quality. The quantitative and qualitative findings indicate that the challenges for a fall-free bathroom are associated with a lack of facilities and unmet environmental qualities. The level of importance of these two aspects is significantly related to their power of access, safety and technology usage during emergency management. This study goes beyond Gleisner, Rose, and Trask's (2022) work by quantifying a user-centred approach regarding priority rankings of these two aspects.

4.1 | Supporting Facilities

The supporting facilities in an older-friendly bathroom are commonly studied (Baek and Jeong 2021; Camp et al. 2021; Koh et al. 2022; Mace 1998; Mullick 2001). However, in the IPA graph, unlike the previous universal design research (Dong and Clarkson 2005; Mace 1998; Mullick 2001; Mullick, Preiser, and Ostroff 2001), an accessible emergency alarm system was not rated as important as wall-mounted grab bars and built-in shower seats for a fall-free bathroom. This may be due to a cultural issue or individual preferences. In line with Gleisner, Rose, and Trask's (2022) study, this difference highlights the necessity of a good level of coherence between the physical environment, user needs and assistive devices. Moreover, the qualitative findings also point out the multidimensional role of the supporting facilities, which were presented under comfort and emergency management themes. This critical role of the supporting facilities is also acknowledged by Baek and Jeong (2021), who developed universal safety design guidelines to create safe and comfortable environments for all people.

Using technology represents another form of supportive agent to help older adults maintain their independence. It is developing rapidly for healthy ageing while reducing the burden on geriatric care (Camp et al. 2021). Smart technologies have many potential benefits for fall detection and prevention (Koh et al. 2022). However, designers, service providers and researchers should think twice if the context is the bathroom. Because of the privacy issues stated by many researchers (King, Holliday, and Andrews 2018), this study also found quantitatively and qualitatively that monitoring the user was a challenge in the bathroom area. Because of the bathing activity being mostly about cleaning the surface of the skin, body-worn technologies were also questioned and not well received by some participants. Thus, identifying the types of technology appropriate for designing fall-free bathrooms need to be carefully analysed. More work is required for an older-friendly combination of body-worn and environmentally based technologies as supporting facilities (hybrid smart systems).

The most raised concern regarding the supporting agents was the level of satisfaction. The physical appearance of these facilities impacted the priority levels ranked by the older adults. Regardless of their performance, their importance ranking could be lower than the overall average ratings in importance. The participants addressed the need to change the grab bars' institutional and bulky look during the open-ended questions. Thus, as Burton, Reed, and Chamberlain (2011) stated, attention should be drawn to the design of these facilities.

4.2 | Indoor Environmental Quality

The indoor environmental quality of buildings affects people's comfort and well-being (Willems, Saelens, and Heylighen 2020). Indoor environmental quality refers to indoor conditions related to the occupant's health, air quality, lighting, thermal conditions and ergonomics. In the study, the levels of importance and performance of lighting and ventilation were significantly different than the other items. We depicted these two items, along with slip-resistant floor material, in Quadrant 1 as a result of the IPA findings and also coded as the critical requirements for error-proof design, safety and comfort based on the thematic analysis results. These quantitative and qualitative results align with Baek and Jeong's study (2021), which proposed universal safety design guidelines to increase sustainability and ensure safety and health. These guidelines responded to ageing and globalisation to predict and prevent future environmental risks. The findings of this study indicate that sustainable indoor environmental quality in bathrooms could ensure the long-term capability, quality and capacity of a fall-free design. As stated by Welsh and Kivisto (2014), the study participants addressed that efficient lighting systems, adequate ventilation and durable slip-resistant floor systems are essential to maintain or support a fall-free bathing activity or toileting process in the long term. They can pave the way for thermally and visually comfortable bathrooms while providing fail-safe environments for older adults and offering indoor quality to minimise falls for everyone regardless of age, size and ability. However, even if indoor environmental quality parameters are satisfied, users still cannot feel relaxed about experiencing falls (Willems, Saelens, and Heylighen 2020). Thus, understanding the lived experience is critical to minimise the risk of bathroom-related fall problems.

5 | Limitations

The study has several limitations that require attention. Firstly, the questionnaire exclusively targeted the shower/bathtub area of the bathroom and focused on the bathing activity. For instance, factors such as toilet accessibility, handrail placement or flooring materials could also significantly impact older adults' safety and independence in the bathroom. Given the significant role of toileting in falls and fall-related injuries among older adults (Mascarenhas et al. 2019), it is crucial to consider the various aspects of toilet/commode usage and their importance–performance priority levels. Toilet-related tasks encompass a range of complex activities, including navigating to and from the toilet

facility, transferring on and off the toilet or commode, maintaining hygiene and rearranging clothing afterwards (Fong and Feng 2021). Moreover, toilet falls are particularly prevalent at night and are more frequently experienced by individuals aged over 80 years (Zou et al. 2023). Therefore, adopting a user-centred approach becomes imperative for analysing the correlations between older adults' attitudes towards using age-friendly toilet/commode facilities and their self-rated performance in overall toilet activities.

Secondly, although the study considered the perspectives of older adults, it did not account for the viewpoints of caregivers, who often play a pivotal role in assisting older adults, especially in bathroom activities. Caregivers may have different perceptions of which features or interventions are most critical for ensuring safety and independence in the bathroom, thus providing valuable insights that were not captured in the study.

Thirdly, the sample size was restricted to 295 participants. Such a limited sample size may restrict the generalisability of the findings. With a larger and more diverse sample, including individuals from various socioeconomic backgrounds and living conditions, the study's conclusions could be more robust and applicable to a broader population of older adults. Differences in socioeconomic status could affect results by influencing individuals' preferences and priorities regarding bathroom design and safety features. For example, those with higher income may prioritise luxury amenities, whereas those with lower income may prioritise affordability and functionality. Exploring these differences is essential for developing inclusive and effective fall-free bathroom designs.

Given these limitations, it becomes evident that further research is essential to validate and expand upon the findings of the present study.

Future studies could address these limitations by employing more comprehensive assessments, incorporating perspectives from older adults and caregivers and recruiting larger sample sizes to ensure greater representativeness and reliability of the results. Consequently, research on ageing should prioritise the interdisciplinary aspects of bathroom design. The complexity of fall prevention includes not only designing specific solutions but also appropriate technology usage in bathing and toileting activities that meets older adults' needs. Further research would focus on technology acceptance models of different smart technologies. Cross-cultural studies could be conducted. Researchers could test radar and wearable sensor technologies for different fall scenarios. Designers could develop bathroom layouts with different lighting and ventilation conditions as well as varying levels of slipperiness and clutter to test and compare users' reactions to falls.

6 | Conclusions

We followed a mixed-method research design approach in this study to investigate older adults' prioritisation of a fall-free bathroom. This involved utilising the IPA method alongside in-depth interviews featuring open-ended questions. The combination of these methods added significant value in identifying users' ranked priority levels.

The study holds both theoretical and practical implications by linking well-established bathroom and shower attributes to the importance and performance priority levels of older adults. Theoretically, it sheds light on the relationship between the most crucial elements and those that bring the highest satisfaction, emphasising the need for alignment with older adults' physiological and cognitive abilities. It emphasises the significance of integrating both quantitative and qualitative viewpoints in research efforts aimed at improving the safety and well-being of older individuals. By highlighting the importance of sustainable inclusion and technology usage in fall-free bathroom design, educational curricula can be updated to emphasise these aspects, ensuring that future practitioners are equipped with the knowledge and skills to address older adults' needs effectively.

On a practical level, creating a bathing area tailored to the needs of older individuals can serve as a foundation for initiatives to enhance their quality of life. Although the results are specific to Türkiye, the study contributes to the broader literature on nursing, design, ergonomics and ageing studies by providing insights into what constitutes a fall-free bathroom environment and bathing activity from the perspective of users' prioritised levels of importance and performance. Practitioners in geriatric and gerontological nursing, architecture and health care can benefit from the research findings to guide the development and implementation of fall-free bathroom designs. Policymakers can leverage the insights from this research to inform guidelines and regulations related to building codes, accessibility standards and health care policies. The study's focus on sustainable inclusion highlights incorporating sustainable materials, energy-efficient technologies and environmentally friendly practices by nursing practitioners, designers and policymakers who can create bathroom environments that not only enhance safety and accessibility but also contribute to broader sustainability goals.

Author Contributions

Y.A. and B.B. involved in conceptualisation, data analysis, writing–original draft, writing–review and editing, reading and approving the final version of the manuscript. Y.A. involved in methodology.

Acknowledgements

The authors would like to thank all the study participants, interviewers, the five architects, the five interior architects and the two Turkish academicians who translated the items for their valuable contributions to this study.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data supporting this study's findings are available from the corresponding author upon reasonable request.

References

Afacan, Y. 2019. "Extending Importance–Performance Analysis (IPA) Approach to Turkish Older People's Self-Rated Home Accessibility." *Journal of Housing and the Built Environment* 34: 619–642. https://doi.org/10.1007/s10901-019-09645-3.

Afifi, M., M. Al-Hussein, and A. Bouferguene. 2015. "Geriatric Bathroom Design to Minimize Risk of Falling for Older Adults—A Systematic Review." *European Geriatric Medicine* 6, no. 6: 598–603. https://doi.org/10.1016/j.eurger.2015.05.004.

Amin, M. G., Y. D. Zhang, F. Ahmad, and K. C. D. Ho. 2016. "Radar Signal Processing for Elderly Fall Detection: The Future for In-Home Monitoring." *IEEE Signal Processing Magazine* 33, no. 2: 71–80. https://doi.org/10.1109/MSP.2015.2502784.

Baek, S. Y., and B. Y. Jeong. 2021. "Universal Safety Design (USD) and Sustainability: Comparison of Guidelines Between Universal Design (UD) and USD." *Applied Sciences* 11: 4413. https://doi.org/10.3390/app11104413.

Banks, M., D. Halstead, and M. LeRoux. 2020. "Aging in Place: Causes and Importance of Fall Prevention Education." *Critically Appraised Topics* 5. https://commons.und.edu/cat-papers/5.

Barton, H. J., E. Pflaster, S. Loganathar, et al. 2023. "What Makes a Home? Designing Home Personas to Represent the Homes of Families Caring for Children With Medical Complexity." *Applied Ergonomics* 106: 103900. https://doi.org/10.1016/j.apergo.2022.103900.

Boge, J., S. Callewaert, and K. A. Petersen. 2019. "The Impact of Bathroom Design on Privacy for Users With Special Needs." *Ageing International* 44: 300–317. https://doi.org/10.1007/s12126-017-9311-9.

Braun, V., and V. Clarke. 2006. "Using Thematic Analysis in Psychology." *Qualitative Research in Psychology* 3, no. 2: 77–101. https://doi.org/10.1191/1478088706qp063oa.

Burton, M., H. Reed, and P. Chamberlain. 2011. "Age-Related Disability and Bathroom Use." *Journal of Integrated Care* 19, no. 1: 37–43. https://doi.org/10.5042/jic.2011.0034.

Camp, N., M. Lewis, K. Hunter, et al. 2021. "Technology Used to Recognize Activities of Daily Living in Community-Dwelling Older Adults." *International Journal of Environmental Research and Public Health* 18, no. 1: 163. https://doi.org/10.3390/ijerph18010163.

Carter, S. E., E. M. Campbell, R. W. Sanson-Fisher, S. Redman, and W. J. Gillespie. 1997. "Environmental Hazards in the Homes of Older People." *Age and Ageing* 26, no. 3: 195–202. https://doi.org/10.1093/ageing/26.3.195.

Chen, M., H. C. Murphy, and S. Knecht. 2016. "An Importance Performance Analysis of Smartphone Applications for Hotel Chains." *Journal of Hospitality and Tourism Management* 29: 69–79. https://doi.org/10.1016/j.jhtm.2016.05.001.

Clarkson, P. J., and R. Coleman. 2015. "History of Inclusive Design in the UK." *Applied Ergonomics* 46: 235–247. https://doi.org/10.1016/j.apergo.2013.03.002.

Da Silva, M. B. C., S. A. Moschen, B. Cecatto, and F. Larentis. 2022. "Perceived Attributes and Dimensions of Accessibility in Adapted Bathrooms." *Building Research & Information* 50, no. 1: 60–73. https://doi.org/10.1080/09613218.2021.1943643.

DeSouza, R., and C. Chard. 2022. "Using Value Equity Drivers to Understand Parents' Perspectives of Youth Summer Hockey Camps: An Importance–Performance Analysis." *Leisure/Loisir* 46, no. 2: 293–319. https://doi.org/10.1080/14927713.2021.1971556.

Dong, H., and P. J. Clarkson. 2005. "Combating Barriers to Inclusive Design: Evaluation of an Inclusive Design Toolkit." In *DS 35: Proceedings of the 15th International Conference on Engineering Design (ICED'05)*, Melbourne, Australia, 403–404.

Engelen, L., M. Rahmann, and E. de Jong. 2022. "Design for Healthy Ageing—The Relationship Between Design, Well-Being, and Quality of Life: A Review." *Building Research & Information* 50, no. 1–2: 19–35. https://doi.org/10.1080/09613218.2021.1984867.

European Commission Directorate-General for Employment, Social Affairs and Inclusion. 2021. *Long-Term Care Report: Trends, Challenges and Opportunities in an Ageing Society*, Vol. I. Luxembourg City, Luxembourg: Publications Office of the European Union. https://doi.org/10.2767/677726.

Fong, J. H., and J. Feng. 2018. "Comparing the Loss of Functional Independence of Older Adults in the U.S. and China." *Archives of Gerontology and Geriatrics* 74: 123–127. https://doi.org/10.1016/j.archger.2017.10.020.

Fong, J. H., and Q. Feng. 2021. "Toileting Disability Among Older Adults in China and Role of Environmental Factors." *Journal of Aging and Health* 33, no. 10: 852–864. https://doi.org/10.1177/08982643211015026.

Gleisner, A. S., L. Rose, and C. Trask. 2022. "Toward Safety and Autonomy in the Home Bathroom: Identifying Challenges, Needs and Gaps." *Applied Ergonomics* 105: 103865. https://doi.org/10.1016/j.apergo.2022.103865.

Hassanain, M. A., M. O. Sanni-Anibire, A. S. Mahmoud, and W. Ahmed. 2019. "Post-Occupancy Evaluation of Research and Academic Laboratory Facilities." *International Journal of Building Pathology and Adaptation* 38, no. 5: 797–810. https://doi.org/10.1108/IJBPA-12-2018-0097.

Hauer, K., S. E. Lamb, E. C. Jorstad, C. Todd, and C. Becker (on behalf of the Profane-Group). 2006. "Systematic Review of Definitions and Methods of Measuring Falls in Randomised Controlled Fall Prevention Trials." *Age and Ageing* 35, no. 1: 5–10. https://doi.org/10.1093/ageing/afi218.

Insch, A. 2010. "Managing Residents' Satisfaction With City Life: Application of Importance-Satisfaction Analysis." *Journal of Town & City Management* 1, no. 2: 164–174.

JASP. 2022. "A Fresh Way to Do Statistics." https://jasp-stats.org.

Karltun, A., J. Karltun, M. Berglund, and J. Eklund. 2017. "HTO—A Complementary Ergonomics Approach." *Applied Ergonomics* 59: 182–190. https://doi.org/10.1016/j.apergo.2016.08.024.

Kenny, R. A., R. Romero-Ortuno, and P. Kumar. 2017. "Falls in Older Adults." *Medicine* 45, no. 1: 28–33. https://doi.org/10.1016/j.mpmed.2016.10.007.

Kim, T., S. D. Choi, and S. Xiong. 2020. "Epidemiology of Fall and Its Socioeconomic Risk Factors in Community-Dwelling Korean Elderly." *PLoS One* 15, no. 6: e0234787. https://doi.org/10.1371/journal.pone.0234787.

Kimiafar, K., M. Farrokhi, F. Manouchehri Monazah, M. Khadem-Rezaiyan, and M. Sarbaz. 2021. "Fall-Related Hospitalisation of Patients in Iran." *Chinese Journal of Traumatology* 24, no. 2: 115–119. https://doi.org/10.1016/j.cjtee.2021.01.001.

King, E. C., P. J. Holliday, and G. J. Andrews. 2018. "Care Challenges in the Bathroom: The Views of Professional Care Providers Working in Clients' Homes." *Journal of Applied Gerontology* 37, no. 4: 493–515. https://doi.org/10.1177/0733464816649278.

Kivimaki, T., M. Stolt, A. Charalambous, and R. Suhonen. 2020. "Safety of Older People at Home: An Integrative Literature Review." *International Journal of Older People Nursing* 15: e12285. https://doi.org/10.1111/opn.12285.

Koh, L., L. Mackenzie, M. Meehan, D. Grayshon, and M. Lovarini. 2022. "The Understanding and Experience of Falls Among Community-Dwelling Adults Aged 50 and Over Living With Mental Illness: A Qualitative Study." *Aging & Mental Health* 27, no. 4: 789–796. https://doi.org/10.1080/13607863.2022.2036949.

Lansley, P., C. McCreadie, A. Tinker, S. Flanagan, K. Goodacre, and A. Turner-Smith. 2004. "Adapting the Homes of Older People: A Case Study of Costs and Savings." *Building Research & Information* 32, no. 6: 468–483. https://doi.org/10.1080/0961321042000269429.

Lee, J. S. W., T. Kowk, P. C. Leung, and J. Woo. 2006. "Medical Illnesses are More Important Than Medications as Risk Factors of Falls in Older Community Dwellers? A Cross-Sectional Study." *Age and Ageing* 35, no. 3: 246–251. https://doi.org/10.1093/ageing/afj056.

Lu, X., Y. Luo, and B. Hu. 2022. "Exploring Older Adults' Nighttime Trips to the Bathroom Under Different Lighting Conditions: An Exploratory Field Study." *Health Environments Research & Design Journal* 15, no. 4: 167–182. https://doi.org/10.1177/19375867221113067.

Mace, R. L. 1998. "Universal Design in Housing." *Assistive Technology* 10, no. 1: 21–28. https://doi.org/10.1080/10400435.1998.10131957.

Mahoney, F. I., and D. W. Barthel. 1965. "A Simple Index of Independence Useful in Scoring Improvement in the Rehabilitation of the Chronically Ill." *Maryland State Medical Journal* 6: 493–507.

Martilla, J., and J. James. 1977. "Importance–Performance Analysis." *Journal of Marketing* 41: 77–79. https://doi.org/10.2307/1250495.

Mascarenhas, M., K. D. Hill, A. Barker, and E. Burton. 2019. "Validity of the Falls Risk for Older People in the Community (FROP-Com) Tool to Predict Falls and Fall Injuries for Older People Presenting to the Emergency Department After Falling." *European Journal of Ageing* 16: 377–386. https://doi.org/10.1007/s10433-018-0496-x.

Mauritzson, E., K. J. McKee, M. Elf, and J. Borg. 2023. "Older Adults' Experiences, Worries and Preventive Measures Regarding Home Hazards: A Survey on Home Safety in Sweden." *International Journal of Environmental Research and Public Health* 20: 1458. https://doi.org/10.3390/ijerph20021458.

McCullagh, M. C. 2006. "Home Modification: How to Help Patients Make Their Homes Safer and More Accessible as Their Abilities Change." *AJN, The American Journal of Nursing* 106, no. 10: 54–63. https://doi.org/10.1097/00000446-200610000-00033.

Ministry of Family, Labour and Social Services of the Republic of Türkiye. 2020. "Accesibility Guidance." https://www.aile.gov.tr/media/65613/erisilebilirlik_kilavuzu_2021.pdf.

Moakley, T. J., and S. Braybrooke. 1987. "Adaptable Accessibility: Bathroom Design for the Disabled." *Interior Design* 58, no. 14: 248–251.

Mullick, A. 2001. "Bridging the Gap Between Human Factors and Environmental Design: A Universal Bathroom Case Study." In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, Los Angeles, CA.

Mullick, A., W. F. E. Preiser, and E. Ostroff. 2001. "Universal Bathrooms." In *Universal Design Handbook*, edited by W. F. E. Preiser, 42.41–42.24. New York: McGraw-Hill.

O Shea, E. C., S. Pavia, M. Dyer, G. Craddock, and N. Murphy. 2016. "Measuring the Design of Empathetic Buildings: A Review of Universal Design Evaluation Methods." *Disability and Rehabilitation: Assistive Technology* 11, no. 1: 13–21. https://doi.org/10.3109/17483107.2014.921842.

Ölmez, E., M. O. Özsoy, R. Jabiyev, et al. 2024. "Bathroom Environment Safety Tracking System." *Proceedings of the IEEE 32nd Conference on Signal Processing and Communications Applications*, in Turkish, May 15–18, 2024, Tarsus, Mersin, Türkiye.

Qun, H., and Z. Nana. 2009. "Product Creative Design of Home Bathroom Under the Guidance of the Idea of Universal Design." In *Second International Symposium on Computational Intelligence and Design*, Changsha, China, 100–102. https://doi.org/10.1109/ISCID.2009.173.

Saldana, J. 2016. *The Coding Manual for Qualitative Researchers*. 3rd ed. London: Sage Publications.

Sanford, J. A., and M. B. Megrew. 1995. "An Evaluation of Grab Bars to Meet the Needs of Older Adults." *Assistive Technology* 7, no. 1: 36–47. https://doi.org/10.1080/10400435.1995.10132250.

Scheffer, A. C., M. J. Schuurmans, N. van Dijk, T. van der Hooft, and S. E. de Rooij. 2008. "Fear of Falling: Measurement Strategy, Prevalence, Risk Factors and Consequences Among Older Persons." *Age and Ageing* 37, no. 1: 19–24. https://doi.org/10.1093/ageing/afm169.

Schoene, D., C. Heller, Y. N. Aung, C. C. Sieber, W. Kemmler, and E. Freiberger. 2019. "A Systematic Review on the Influence of Fear of Falling on Quality of Life in Older People: Is There a Role for Falls?" *Clinical Interventions in Aging* 14: 701–719. https://doi.org/10.2147/CIA.S197857.

Skok, W., A. Kophamel, and I. Richardson. 2001. "Diagnosing Information Systems Success: Importance–Performance Maps in the Health Club Industry." *Information & Management* 38: 409–419.

Stevens, M., C. D. Holman, and N. Bennett. 2001. "Preventing Falls in Older People: Impact of an Intervention to Reduce Environmental Hazards in the Home." *Journal of the American Geriatrics Society* 49, no. 11: 1442–1447. https://doi.org/10.1046/j.1532-5415.2001.4911235.x.

Story, M. F. 1998. "Maximizing Usability: The Principles of Universal Design." *Assistive Technology* 10, no. 1: 4–12.

Sveistrup, H., D. Lockett, N. Edwards, and F. Aminzadeh. 2006. "Evaluation of Bath Grab Bar Placement for Older Adults." *Technology and Disability* 18, no. 2: 45–55. https://doi.org/10.3233/TAD-2006-18201.

Taoz, M., and Y. Afacan. 2020. "Simulated Physical Ageing: A Prioritized Persona-Based Model for Accessible Interiors in Senior Housing Environments." *Indoor and Built Environment* 31, no. 8: 2115–2133. https://doi.org/10.1177/1420326X20952817.

Tinetti, M. E., D. I. Baker, G. McAvay, et al. 1994. "A Multifactorial Intervention to Reduce the Risk of Falling Among Elderly People Living in the Community." *New England Journal of Medicine* 331, no. 13: 821–827. https://doi.org/10.1056/nejm199409293311301.

Turkish Standard. 2011. "TS 9111: The Requirements of Accessibility in Buildings for People With Disabilities and Mobility Constraints." https://tofd.org.tr/Images/ts-9111-2011.pdf.

Turkish Statistical Institute—Turkstat. 2021a. "Elderly Statistics, 2021." https://data.tuik.gov.tr/Bulten/Index?p=Istatistiklerle-Yaslilar-2021-45636.

Turkish Statistical Institute—Turkstat. 2021b. "Survey on Building and Dwelling Characteristics, 2021." https://data.tuik.gov.tr/Bulten/Index?p=Bina-ve-Konut-Nitelikleri-Arastirmasi-2021-45870.

United Nations, Department of Economic and Social Affairs, Population Division. 2019. "World Population Prospects 2019: Data Booklet." ST/ESA/SER. A/424.

Üstün, T. B. 2010. *Measuring Health and Disability [Elektronisk Resurs] Manual for WHO Disability Assessment Schedule WHODAS 2.0*. Geneva: World Health Organization.

Watchorn, V., D. Hitch, R. Tucker, P. Frawley, K. Aedy, and C. Grant. 2022. "Evaluating Universal Design of Built Environments: An Empirical Study of Stakeholder Practice and Perceptions." *Journal of Housing and the Built Environment* 38: 1491–1510. https://doi.org/10.1007/s10901-022-09981-x.

Welsh, P. G., and E. Kivisto. 2014. "Providing High-Quality Care in North Carolina Nursing Homes." *North Carolina Medical Journal* 75, no. 5: 336–340. https://doi.org/10.18043/ncm.75.5.336.

Willems, S., D. Saelens, and A. Heylighen. 2020. "Comfort Requirements Versus Lived Experience: Combining Different Research Approaches to Indoor Environmental Quality." *Architectural Science Review* 63, no. 3–4: 316–324. https://doi.org/10.1080/00038628.2019.1705754.

Zou, M., R. Lu, Y. Jiang, et al. 2023. "Association Between Toileting and Falls in Older Adults Admitted to the Emergency Department and Hospitalised: A Cross-Sectional Study." *BMJ Open* 13: e065544. https://doi.org/10.1136/bmjopen-2022-065544.