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# Exploring Older Adults' Perceptions of Stair Hazards and an m-health Fall Prevention App: A Focus Group Study

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**Abstract**

Older adults are disproportionately susceptible to hospitalizations and fatalities due to stair-related falls. While many intrinsic risk factors, such as mobility and vision, may increase the likelihood of falls on stairs, features of the stairs that increase the risk of falls are understudied. This study aimed to capture older adults' perspectives of stair falls, as well as introduce the Safer Steps app and explore its feasibility in this population. This m-health technology was designed to gather data on stair-related falls and identify hazardous stair features (e.g., the absence of handrails, uneven steps). Capturing older adults' perspectives

of the role of the built environment in stair-related falls is crucial for fostering the adoption and use of the Safer Steps app in this demographic. Fifteen older adults (*M* = 73 years, SD = 5.29) participated in focus groups discussing falls, stair-related falls, technology use and the design concept of the Safer Steps app. Reflexive thematic analysis revealed that participants expressed fear of falling and cited intrinsic risk factors, such as age, medications, and footwear, alongside extrinsic risk factors related to the built environment, to be major causes of stair-related falls. They highlighted the significance of the built environment in fall prevention, particularly surface conditions, step dimensions, and handrails. Most participants were familiar with apps and endorsed the Safer Steps app design to mitigate stair-related fall risk. Findings indicate older adults' willingness to engage in strategies which reduce stair fall risk, such as modifying their behaviour by using handrails and changing footwear, viewing the Safer Steps app as a practical tool for identifying built environment hazards.

**Keywords**
Fall prevention; technology; stair safety; environmental hazards; older adults

## 1. Introduction

Falls have the potential to significantly alter an individual's health status and overall quality of life [1]. Often leading to morbidity, mortality, and decreased independence [2], fall-related injuries cost the Canadian economy $5.6 billion in 2018 [3]. Approximately 20-30% of Canadians over the age of 65 experience at least one fall per year, highlighting the importance of fall prevention awareness [4, 5]. Increased risk of falling among older adults can be associated with many intrinsic and extrinsic factors [6], including the built environment (i.e., the way the stairs are built) and factors such as diabetes [7], cognitive decline [8, 9], visual impairments [10], or low body mass index [11]. Additionally, falls among older adults can lead to serious injuries with reports of upper extremity breaks and fractures, affecting the arms and shoulders, and resulting in trips to the emergency department [4]. In many cases, these fall-related injuries lead to increased physical and mental distress for these individuals, negatively impacting health outcomes [5]. Over the past few decades, studies have shown that falls among older adults increased fear of falling and of leaving one's home [12, 13], which subsequently limited their participation in social activities [2].

### *1.1 Built Environment and Stair-Related Falls*

The built environment (i.e., static structural elements of a given space) plays a significant role in shaping the risk of falls among older adults [14]. Various factors within physical surroundings can contribute to increased vulnerability to falls [14]. Indoor and outdoor stairs are particularly critical areas where older adults may encounter hazards leading to falls [14]. Such static hazards include poorly designed stairs, inadequate handrails, uneven surfaces, poor lighting, and clutter [15-19]. Additionally, stair dimensions and rise-to-run ratios (i.e., the incline of stairs) can impact balance and stability during stair use [20, 21].

Stair-related falls among the older adult age group greatly contribute to injuries and tend to result in serious negative outcomes, such as accidental death [22-24]. Stair-related injuries can be

attributed to the height of the stairs [25], stair edges or foot clearance (i.e., the space or distance between the bottom of a person's foot and the ground or another surface) [24]. Furthermore, studies have found correlations between stair use and increased prefrontal cortex activity [26], elucidating that climbing stairs requires considerable cognitive effort and can increase the likelihood of injuries and falls [27]. Additional cognitive tasks that have been shown to increase the likelihood of falls and/or injuries on stairs include distracting behaviours such as, phone use, carrying items in hands, or having a conversation [28, 29]. Thus, it is imperative to implement fall prevention strategies that integrate modifications to the static built environment, aiming to create safer spaces and diminish the incidence of fall-related injuries on stairs.

Currently, there exist many technological interventions to help reduce falls and improve health [30]. These include software developments, commercial devices, and assistive devices [31]. Fall detection systems have also been found to be useful in-home settings [32]. These fall detection systems equip an individual's home with sensors, which can detect when a fall has occurred, alerting emergency personnel [32]. In addition to this, there exist mobile applications that can help report falls and send alerts, which can quickly bring help to an injured individual [33]. The digital transformation of healthcare has great potential to help reduce risks associated with stair use for older adults, however, the above-mentioned technologies function as fall mitigation, rather than fall prevention strategies.

### *1.2 The Safer Steps App*

Encouraging the utilization of technology among older adults can play a pivotal role in mitigating health-related risks [34]. The Safer Steps mobile application ("app") uses a citizen science method (i.e., the engagement of the public in the collection and processing of data required for a research study) similar to Frei et al. [35] to capture images of indoor and outdoor stairs for the purpose of identifying stair features that may lead to falls. The app follows a step-by-step process that guides users on how to capture images based on the questions they answer such as the indoor or outdoor location, the number of steps, the number of flights, and the amount of light near the staircase. The user is asked whether anyone has experienced falls on the set of stairs, helping identify dangerous stairs and stair features in the participant's home and community. In its present beta form, the app requires participants to print out a QR code provided to them by the research team. The app then prompts the user to place the QR code in various positions on the stairs in order for the research team to validate measurements (length/height of the stairs). This also provides automatic digital data that can later be interpreted by the research team [36].

This study sought to assess the potential causes of stair-related falls as reported by older adults, as well as their opinions on the Safer Steps app before its release for public use. Focus groups were used to investigate: (1) the hazards of stair features and their role in stair-related falls, and (2) the perceived use of the Safer Steps app in capturing hazardous stair features.

## 2. Materials and Methods

### *2.1 Recruitment*

Study participants were recruited via email through the Council on Aging (COA), National Association of Federal Retirees (NAFR), and Canadian Association of Retired People (CARP) –Ottawa

Chapter newsletters. Recruitment was purposeful, in that we targeted older adults that lived in the community and that were interested in research on falls. The type of housing people lived in was not restricted (i.e., retirement community, apartment, detached house, etc.) to capture a variety of perspectives on stairs, the built environment and the app. Inclusion criteria for the study comprised individuals 65 years or older, without medical conditions that impaired their ability to use mobile-based apps (i.e., macular degeneration, glaucoma, diabetic retinopathy, Alzheimer's, tremors, etc.), and with access to Wi-Fi for participation in a virtual session on Zoom, which were screened using a self-checklist.

Ethical approval for this study was obtained from the University of Ottawa's research ethics board (file #H-08-19-4831).

### *2.2 Research Team*

All of the researchers on this team were women and two members (AA & SF) moderated the focus group sessions. All members were involved in the development of the Safer Steps app. For the focus group sessions, SF was the primary moderator and has expertise in fall-related research with older adults, qualitative research, and has lived experience of an older parent having a fall. AA was learning about qualitative research and their expertise is in health sciences/epidemiology. SF and AA were the primary coders and their experience informed their interpretation of the participant's experiences. The remaining team members were not involved in the data collection or analysis portion of the study but assisted in the preparation of the manuscript (writing/editing our drafts). NE is an expert in research on falls and the built environment, AN is also an expert in research on falls and features of the built environment that contribute to falls, and AM has expertise in older adults with cognitive impairments (dementia).

### *2.3 Research Paradigm and Approach*

In designing this study, we took a social constructionist framework [37], which we paired with a reflexive thematic analysis method [38, 39]. We chose this framework as we believe context is very important when building meaning around experiences of falls and concepts like the built environment. With respects to thematic analysis, we used a blend of inductive (from the participants' data) and deductive (theory-driven: based on our knowledge of fall research) coding and aimed to be flexible in our approach to the data [39].

### *2.4 Data Collection*

Upon meeting the screening criteria, participants received an email containing the consent form and a link and explanations on how to join a virtual focus group meeting session. Additionally, verbal consent was obtained and documented at the beginning of the focus group session. The moderators began by introducing themselves, expressing appreciation for the participants' presence, and offering guidelines for the session. Before delving into the study objectives and session agenda, participants introduced themselves and shared their birth year and employment status.

Based on the semi-structured focus group guide developed by Peng et al. [40], and de Clercq et al. [2], a focus group script was used by the research team to help guide and provide structure to the sessions [41]. The focus groups involved (1) a discussion of the participants' experiences with

falling and the built environment in their homes and communities; (2) an exploration of mobile app use among participants to gauge digital literacy; (3) a brief presentation of the Safer Steps app (via PowerPoint slide show) and (4) a discussion about the usability and importance of the app. The detailed focus group interview guide can be found in Appendix 1. Please see Supplemental Material for the PowerPoint slide show of the Safer Steps app.

Member checking (i.e., summarizing answers and responses back to participants to ensure accurate interpretation of data) was performed during the focus groups to ensure a good comprehension of their perspectives [42]. All focus groups were audio-recorded for transcription and data analysis.

### *2.5 Data Analysis*

The saved audio files were transcribed verbatim using Otter.ai and each transcription was verified by a member of the research team (AA). We used Otter.ai for transcription due to its efficiency in converting audio recordings into text. Microsoft Word was used for organizing and analyzing transcripts. While these tools are not specialized research software, they were chosen for their accessibility and functionality in managing large volumes of data. We ensured the accuracy of transcriptions through manual checks and validation. Participants were given a code ranging from P1 to P15 to protect their identity and privacy. We followed Braun & Clarke's (2006) approach which involves six phases: familiarisation; coding; generating initial themes; reviewing and developing themes; refining, defining and naming themes; and writing up [43]. The researcher and moderator met multiple times to iteratively code the focus group transcripts and become familiar with the data. Together they methodically reviewed the data in relation to the research question, which involved a thorough examination of each line of text, whereby descriptive labels or codes were systematically assigned to encapsulate the key concepts and ideas and explore patterns in the data [38]. Researchers used Microsoft Word for this process highlighting important passages and using the comment function to define codes. Themes were developed based on the researchers' own experiences and knowledge, particularly with a family member who had experienced a fall, and from epidemiological evidence found in the literature on the role of the built environment in falls. Additionally, the researchers reviewed and analyzed the transcripts and passages they identified as relevant and interesting. Once initial themes were generated, the researchers reviewed and adapted the themes to ensure they addressed the research questions.

## 3. Results

### *3.1 Study Participants*

A total of 15 older adults were recruited for this study. As a result, four focus groups were formed: three groups of four participants and one group of three participants. The focus groups were conducted via Zoom from February to August 2022 and lasted 90 minutes, on average. The majority of participants were female (n = 11, 73%) and had a mean age of 73 years (SD = 5.29). All participants were retired individuals. Participants came from diverse backgrounds in terms of age, gender, ethnicity, socioeconomic status, and medical history, with varying experiences with falls, stair-related injuries, and technology. A fall was described as an unintended incident where a person ends up on the ground or a lower surface [44]. The majority of participants were community

dwelling (n = 12, 80%), and all participants reported having stairs in their home. Overall, in their older adulthood, 50% of participants reported experiencing a general fall (both stair and non-stair related falls) in the first two focus groups, and 43% reported a general fall in the last two groups. Demographic information for the focus group participants is presented in Table 1.

**Table 1** Demographic characteristics of participants (N = 15).

| Variable | N (%) |
|---|---|
| Sex | |
| Female | 11 (73.3) |
| Male | 4 (26.7) |
| Ethnicity | |
| Caucasian | 13 (86.7) |
| East-Asian | 1 (6.7) |
| South-Asian | 1 (6.7) |
| Education | |
| Highschool | 2 (13.3) |
| University | 9 (60) |
| Post-graduate | 4 (26.7) |
| Have experienced a fall in your older adulthood? | |
| Yes | 8 (53.3) |
| No | 7 (46.7) |
| Do you know someone who has experienced a fall? | |
| Yes | 15 (100) |
| No | 0 (0) |
| Are you a technology user (phone, tablet, computer, etc.)? | |
| Yes | 6 (40) |
| No | 9 (60) |

### *3.2 Thematic Findings*

Participants shared a multitude of experiences concerning stair-related falls and the subsequent impact on their quality of life. As a result of the focus groups, four key themes emerged, shedding light on participants' diverse experiences with stair-related falls: (1) Perceived factors contributing to stair-related falls; (2) ramifications of stair-related falls; (3) perceived barriers and facilitators to stair modifications; and (4) technology utilization and the Safer Steps app. Each theme was described using subthemes presented in Table 2.

**Table 2** Focus group themes and subthemes.

| Themes | Subthemes |
|---|---|
| **Perceived factors contributing to stair-related falls** | *Intrinsic factors (health conditions and behavioural factors)*<br>*Extrinsic factors (static built environment factors)* |
| **Ramifications of stair-related falls** | *Physical injuries*<br>*Emotional impact* |
| **Perceived facilitators and barriers to stair modifications** | *Awareness and fear*<br>*Healthy aging in place*<br>*Cost*<br>*Aesthetics* |
| **Technology utilization and the Safer Steps app** | *Acceptance of technology and the Safer Steps app*<br>*Critiques of technology and the Safer Steps app* |

3.2.1 Theme 1: Perceived Factors Contributing to Stair-Related Falls

Intrinsic Factors. Decline in physical health was reported to influence the ability of sensory perception and coordination according to participants. These physical age-related changes were reported to often result in vision, balance and gait issues, which contributed to falls.

> "I have vision impairment, somewhat with macular degeneration. And before, even with the cataracts, I was finding myself very uneasy, moving from a sidewalk to a roadway and crossing the street and now going down steps, going up steps." (P14, Group 4).

Several other participants noted that taking medications and low blood pressure, as a result of various health conditions and changes also contribute to falls.

> "Some people fall too because of medication that they're taking…you get dizzy." (P8, Group 2).

Participants reported behavioural factors such as being in a rush or multitasking to be key contributors to falls, as a result of inattention and decreased carefulness.

> "A lot of falls seem to be connected to being in a hurry. Like you're running to get the phone or you're running to get the door, so being hurried seems to be often part of falling." (P8, Group 2).

> "But also having your hands full. One of my neighbors was cleaning up after a party, she was taking glasses downstairs...and turned at the top of the stairs to say something to somebody who was behind her. And poof down she went." (P7, Group 2).

Extrinsic Factors. Factors related to the built environment were reported to be the most common contributors to stair-related falls. Notably, stair features such as handrails and lighting were described as being major determinants of stair safety, playing a protective role in fall risk.

> "I always have a handrail. I always hold on to that". (P6, Group 2).

> "We've got those little motion detector lights at the top and the bottom of our staircase, so that when we need the light to see what's there, it's on." (P3, Group 1).

According to participants, stair surfaces and choice of footwear were also said to work together to increase stair-related fall risk. One participant described how they could be both a safety and hazardous feature.

> "I find my running shoes kind of catch on the carpet. The flipside is my friend's mom was rushing down the stairs in her slippers, wooden stairs, lost her footing somehow. And she never came out of the coma." (P8, Group 2).

Stair dimensions, such as the rise and run, and visual features were noted to alter susceptibility to stair-related falls.

> "The step…the risers? You know the width of the step? Each step. It's not, they're not deep...so you can slip and fall if you miss it." (P13, Group 4).

> "I think it's called nosing. There was a dark nosing across the lip of the step, and a crisscross lighter pattern, sort of a trellis pattern. And I found that aspect of the stairs very helpful because I could see the edge of the stair and I could see where I was going to put my foot, so I really liked that." (P12, Group 4).

### 3.2.2 Theme 2: Ramifications of Stair-Related Falls

Physical Injuries. From having experienced a fall, having known a friend or family member who had fallen, and having knowledge of the impacts of falls, participants had great awareness of the dangers related to stairs and stair-related falls.

> "Yeah, those stairs can be real killers." (P2, Group 1).

> "I've had a few friends fall down an entire flight of stairs. I know three people who died after falling down stairs" (P7, Group 2).

Overall, participants reported a total of five people who had died due to a stair-related fall or injury, highlighting in this group that a fall, specifically on stairs, can have life-altering consequences, not just for the individual, but for family and friends as well.

Emotional Impact. Injuries from falls were reported to significantly impact quality of life. One participant who suffered from a concussion following a fall said, "[T]hat was quite hard for me…that concussion really took a lot out of me…that fall was really hard on me, I must say". (P1, Group 1) While most participants reported on the physical impacts of falls, impacts on mental well-being and subsequent changes in behaviour were also discussed. Participants stated that experiencing and hearing about falls caused distress.

> "I'm a lot more cautious than I used to be. And just because of the frequency of hearing friends fall, and I did a faceplant on the ice. And that really disturbed me. Just like, oh, I can fall." (P7, Group 2).

Another participant mentioned that the stair-related fall which led to the death of their brother, "was quite a revelation, it was quite a wakeup call" (P2, Group 1), indicating that experiences with falls or knowing a peer who has fallen can increase fear of falling in older adults.

### 3.2.3 Theme 3: Perceived Barriers and Facilitators to Stair Modifications

Following the reporting of hazardous stair features by participants, various facilitators and barriers were discussed in terms of making modifications to the built environment. All participants agreed that while creating a safer environment was important, there were factors and obstacles that determined their willingness to implement change.

Awareness and Fear. Participants mentioned that with age, a sense of awareness of increased fall risk developed. This development in turn encouraged participants to create safer environments in their surroundings or engage in safer behaviours.

> "Yeah, my mind changed when I got older. I always have a handrail. I always hold on to that." (P6, Group 2).

Overall, the importance of improving the built environment to ensure safe aging at home was discussed, but there were various factors that participants needed to consider before making the decision to modify stair and built environment features.

Healthy Aging in Place. Numerous participants emphasized the significance of adapting stairs and the overall built environment to facilitate healthy aging in place, notwithstanding whether they implemented any modifications themselves.

> "People don't see these features, they will go for a marble kitchen top, but they will not see the other benefits that might make their life easier. And it only happens when you experience a fall, and then see a change in your lifestyle, right? Somebody falls, they end up in a home, or they have a concussion and lose their mental capabilities. But it's a broad society benefit, and the home builders don't see it as such." (P5, Group 2).

Another participant pointed out that environments designed for the older adult demographic fail to prioritize stair safety, posing risks to healthy aging in place.

> "We have outside stairs, three or four, I guess. And, and there's no railing there and I live in a senior's community. And not one house has an outside railing. And we're one of the younger couples in this neighbourhood. I just find it so weird that they built a neighbourhood, they built a complex, designed for seniors. We've got wider halls and double doors and all this good stuff. And then every single house, you have to go upstairs to get into it." (P7, Group 2).

Overall, participants emphasized the critical need for modifications in both home environments and broader societal infrastructure to promote safe and healthy aging in place, emphasizing the importance of prioritizing features like stair safety for the well-being of older adults.

Cost. Cost was a barrier to implementing changes to the built environment, such as adding handrails and modifying the stair rise or run. One participant stated that changes to the built environment would make being a homeowner expensive. "Yeah, cost. It's always cost. They say it will make housing expensive." (P5, Group 2).

As a result of the perceived costs related to implementing changes to the built environment, many participants reported changes in behavior and adaptations to their daily activities (e.g., increased carefulness, practicing balance exercises at home, and avoiding stairs whenever possible) instead.

Aesthetics. Another major barrier to making stair and built environment modifications was the change in aesthetics. When asked about adding handrails to stairs in the home, one participant stated, "I'd like to sell my house someday. I don't think the house would sell" (P8, Group 2). Moreover, participants indicated that guidance from home builders discouraged alterations to stair features. One participant stated that when inquiring about installing a ramp at her front door, her handyman said, "Oh, you don't want to do that it would destroy the value of your house" (P9, Group 3). The change in aesthetics and home value was a major factor for not modifying the built environment to increase safety.

### 3.2.4 Theme 4: Technology Utilization and the Safer Steps App

In total, 40% of participants reported being frequent users of technology and mobile apps. The most common apps used by participants were news apps, Facebook, Google Maps, game apps and apps related to emails and banking. The use of health-related apps was only reported by two participants, who both stated they used tracking apps to count their steps and distance while walking or hiking.

Acceptance of Technology and the Safer Steps App. Positive feedback regarding the Safer Steps app centered on its potential to educate and empower older adults in preventing falls and implementing built environment and policy change. Participants appreciated the app's simplicity and comprehensiveness, though they noted the necessity of accommodating users with varying levels of technological proficiency.

> "I'd say it's one of the better apps I've seen for seniors in a long time. And I've participated in a couple of these exercises across Canada." (P3, Group 1).

> "I like the fact that you would be tailoring it to your personal situation. So, I would take pictures of the stairs in my home and outside my home, which are quite different from people living in different living environments. So, I think I like that". (P11, Group 3).

Participants further shared their perspectives on factors that could contribute to the positive uptake of the Safer Steps app, such as intergenerational training and linkage of the app to other platforms. They emphasized the importance of integrating the Safer Steps app with existing digital platforms or resources that older adults already use. Participants also mentioned healthcare portals as potential avenues for increasing the benefits of the app. Additional suggestions for increased app use were visual characteristics, such as font size, font color, and contrast:

> "The font contrast would be helpful. On some websites, the stylish colors might be yellow and gray. I have some difficulty with my vision. And I can't read those. So, choose good contrast and not glaring colors. Black on white works for me. But you know, there might be other possibilities. But not to be looking for style, make it more readable. And the options, maybe being able to enlarge the font if possible." (P12, Group 4).

These suggestions seemed to help enhance the app's perceived effectiveness and appeal among older adults.

Critiques of Technology and the Safer Steps App. Participants voiced concerns about potential barriers to the adoption of the Safer Steps app, including issues of responsibility and privacy. These

concerns highlight obstacles that must be overcome for the app to be widely accepted among older adults. Specifically, participants discussed uncertainties regarding responsibility for stair modifications, with some suggesting homeowners, building developers, or government entities. The uncertainty from participants on next steps, once unsafe stairs have been identified, highlights the need for clear guidance and actionable steps to address these hazards effectively. Privacy also emerged as an important consideration in participants' feedback. Participants expressed concerns about the collection and use of personal data, and whether the data would be saved on a Canadian server.

## 4. Discussion

The findings from this qualitative study shed light on the profound consequences that extrinsic factors, such as the static built environment and stair features can have on healthy aging. Participants acknowledged the health risks of falls and reported behavioral changes and increased fear of falling, citing common perceived reasons for stair falls such as footwear, age, and medications. They emphasized the role of the static built environment, particularly surface conditions, step dimensions, and handrails, while endorsing the use of the Safer Steps app to reduce stair fall risk, although concerns were raised about responsibility for addressing identified hazards. Participants displayed a remarkable familiarity with individuals in their social circles who had experienced both major and minor fall-related injuries, which appeared to exert a substantial influence on their perception of fall risk and their own susceptibility.

Current literature supports the influence of various individual factors on fall risk, which aligns with the experiences shared by our participants [45]. Age-related changes, such as declines in vision, fitness level, and overall health, were frequently mentioned as contributing to the risk of falls on stairs [46]. As individuals age, their sensory perception and physical capabilities may be compromised, making them more susceptible to balance and coordination difficulties [47]. Vision impairments, for example, can impact depth perception and hinder the ability to accurately judge the position and layout of stairs [48]. These factors highlight the multifaceted nature of fall risk assessment and prevention, emphasizing the importance of considering a wide range of individual characteristics and circumstances.

While it was acknowledged that falls can happen in various settings, participants emphasized that falls on stairs often result in more severe outcomes (i.e. accidental death). This finding aligns with existing literature on stairs and stair-related falls, confirming that the consequences of stair falls can be particularly serious [22, 49]. The findings reinforce the importance of implementing policies and undertaking home modifications to create safer stairs and improve the built environment. Ensuring the safety of stairs is crucial for reducing the occurrence and severity of falls among older adults. Policies that prioritize the installation of handrails, adequate lighting, and other safety features can play a significant role in preventing falls on stairs. Home modifications, such as installing anti-slip surfaces, removing tripping hazards, and adapting the design of stairs to accommodate older adults' needs, are vital for enhancing safety and reducing the risk of falls [50]. By addressing the specific hazards associated with stairs and focusing on comprehensive interventions, communities can make significant strides in preventing stair-related falls. This includes collaboration between policymakers, healthcare professionals, architects, and individuals themselves to raise awareness, advocate for safer stair designs, and promote the importance of

regular maintenance and upkeep of staircases. Implementing evidence-based guidelines and standards for the construction and maintenance of stairs can contribute to the creation of more accessible and secure environments for older adults.

Overall, the themes generated from the interviews reflect older adults' perspectives on the risks and circumstances associated with falls in the built environment. These perspectives highlight significant psychological concerns about falling in older age and reveal a stigmatization and hesitancy to address fall risks, possibly due to financial constraints or a belief that fall prevention is a societal responsibility rather than a personal one.

Upon introducing the Safer Steps app and explaining its purpose, the older adults in the focus groups displayed a willingness to participate in data collection. However, not all participants fully grasped the potential benefits of the app. Most participants expressed enthusiasm for m-health apps that could work in conjunction with other health-related applications and link to their health records, allowing them to track changes and discuss them with their healthcare providers. These findings align with a study conducted by Manini et al. [51], which reported that older adults reacted positively to using smartwatches for improved patient-provider communication. The desire for connectivity and integration with existing health apps and systems demonstrates the older adults' interest in leveraging technology to enhance their healthcare experience and foster more effective communication with their healthcare providers. Participants recognized the app's benefits but stressed the importance of further exploration and hands-on experience to assess its effectiveness. Iterative refinement and testing based on participant feedback will enhance usability and maximize the app's impact in promoting safer aging in place and reducing fall risks on stairs for older adults.

Our findings reveal novel insights into the psychological impact of falls on older adults and the social and financial barriers to implementing fall prevention strategies. While intrinsic and extrinsic risk factors are well-documented, our study uniquely highlights older adults' perspectives on these issues and their hesitancy to address fall risks, while exploring how digitization and the use of technology can play a role in encouraging proactive measures to enhance safety in the home environment.

### *4.1 Study Limitations*

One of the objectives of this study was to see what older adults thought about the Safer Steps app. As the app is still being modified, it was unavailable to the participants who participated in these focus groups. As such, participants offered their opinion on general m-health app use and their understanding of the Safer Steps app based on a presentation of the app’s features. It is our intention to re-solicit the same individuals to try the app for themselves when the app is ready and then ask them to provide feedback on the app usability and perceived benefits. It should also be noted that individuals who responded to our recruitment ads for this study clearly had a strong interest in falls and in particular stair-related falls. Half of the participants had fallen, and several had a loved one or a friend have a serious stair-related fall injury. This sample may not be representative of all older adults but many of the reports from this sample align with what has been found in the literature. In addition, the small sample size of our study may restrict the generalizability of the findings to a broader population. Furthermore, in the interest of time, we were unable to conduct member checking throughout the data collection process, and rather only

solicited clarifications during the focus groups. This may have limited the rigor of the study, as the interpretations of results and findings were not validated with the focus group members.

## 5. Conclusion

With a wide range of intrinsic and extrinsic factors that contribute to fall risk, it is important to implement changes to both the built environment and relevant policy to support the aging population. Various factors in the built environment, such as a slippery stair surface, inadequate stair dimensions, and missing handrails contribute to falls. These contributors can be changed through building modifications. However, barriers such as cost, and aesthetics exist to prevent older adults from implementing these changes. Fall prevention is crucial to ensuring the safety and well-being of older adults, thus in the long term, the use of the Safer Steps app aims to provide data/data-driven evidence to suggest government policy change and encourage individuals to implement modifications in the environment, subsequently decreasing fall risk. Future research should be aimed at user experience and engagement of the Safer Steps app.

## Appendix

### Appendix 1 Detailed Focus Group Guide

***Welcome and Introduction:***

- The researcher welcomes everyone to the discussion and introduces herself and her colleague.
- Before we have you introduce yourselves, I need to review the consent form with you explaining the contents and ask if you have any questions and then ask if you consent to having this focus group session recorded.
- Moderator explains the contents of the consent and asks if there are any questions
- Pause
- All the participants are asked to introduce themselves and state if they agree to the recording of the session (stating it out loud)
- Could you also tell us how you heard about this study, as well as a little about yourself, what your year of birth was and what your past or current employment is?

***We Do Have Some Housekeeping Rules:***

- Everyone is encouraged to participate
- No one will be forced to participate
- All answers/opinions are encouraged—there are no “dumb” questions or comments
- Everyone’s opinion is important
- No one is to laugh at or dismiss another person’s opinion/comment
- Only one person should talk at a time and give everyone equal opportunity to participate
- The researcher will ask a few questions, but you are welcome to go back to a previous
- question if we have already moved to the next question

**The researcher explains the aim of the study to the participants:** This research study focuses on fall prevention and an innovative way to reduce fall risk. We would like to hear from you what

factors you think increase and decrease your risk of falling, we would like to hear about any mobile applications you use and finally, through a short presentation, we will share our planned mobile application called the Safer Steps app and ask you what you think about it.

***Questions on Falls:***

I would like to start by asking you about falls. And by a fall I mean a sudden and unintentional change in position resulting in an individual landing at a lower level such as on an object, the floor, or the ground, and this can be with or without injury (PHAC definition).

- With this definition of falls in mind…Have any of you had any recent falls? (in the last year)
- Can you tell me about the fall?
- What do you think contributed to this fall?
- Were you injured with this fall?
- Did you seek medical help? (if yes from whom, if not why)
- What factors do you think can increase your chance of falling?
- (Prompts if needed: Prompt about specific factors related to (a) body functions and structure level, (b) activities and participation level, and (c) environmental factors.)
- What factors do you think can decrease your chance of falling?
- (Prompts if needed: Prompt about specific factors related to (a) body functions and structure level, (b) activities and participation level, and (c) environmental factors.)
- Have you ever fallen on stairs? Can you tell me about this event? What happened? Where did it occur?
- Can you tell me anything about the features of the/your stairs? For example, are the steps even, do you find them steep, do you have a handrail, do you have lighting at the top or bottom of the stairs?
- Has anyone else fallen on the stairs in your home?
- If not already described… Have you fallen on stairs outside your home? Can you tell me about this?
- Do you think there are any gender or age differences in falling?
- If you have fallen, has this changed anything about your daily activities or places you would frequent? In what way?

***Member checking:*** The participants' responses are summarized and read back to them. They are invited to make changes, add information, or clarify their contributions.

***Questions on Mobile Apps: *Note Depending on the Time This Section Can Be Shortened to Favour the Presentation of the Safer Steps App (Italicized Questions Can Be Skipped)***

Now I would like to ask you a few questions about mobile applications or apps that you might have on your cell phone or tablet. To be clear, a mobile application or app is a computer program or software application designed to run on a mobile device such as a phone, tablet, or watch. For example, google maps is an app I sometimes use to choose my best route to Montreal.

- Can you tell us about the kinds of mobile phone apps you use?
- How frequently do you use them?
- What kind of health apps do you think exist?

- *Do you have any health or wellness apps on your phone? (if needed example Samsung Health, Noom, Headspace…)*
- *How long ago did you download them?*
- *How frequently do you use them?*
- For all of you who do not have any health phone apps – why don't you?
- For everyone who uses health apps--What do you like about the app?
- What are your favorite features? What do you dislike about the app? Is there anything you would like to change about it? Why did you get (What motivated you to get) the health app?

***Member checking:*** The participants' responses are summarized and read back to them. They are invited to make changes, add information, or clarify their contributions.

***Present the Safer Steps App Prototype and Its Features:***

For this last segment, we would like to share with you our prototype for a mobile health application to improve stair safety and reduce stair-related falls. We are particularly interested in older adults' perspectives on this app as we would like to design it in a way that is usable and of interest to older adults.

***Amrin Presents Short Slide Deck – and Asks the Participants if They Have Any Questions.***

**Then we will ask the participants the following questions:**

- What do you think about this app?
- What do you like about the app? What are your favorite features?
- What do you dislike about the app? Is there anything you would like to change about it?
- Do you feel the app will provide important information on stair falls?
- What type of information do you think will be relevant?
- What information would be most relevant to you?
- Do (Would) you evaluate the quality and credibility of an app before you download it? How?
- What would ensure your continued usage of an app?
- Would you be likely to download this particular app? Why?
- Would you tell others about this particular app? Why?
- What changes do you think are needed to help prevent falls on stairs?
- Who do you think should be responsible for implementing these changes in your house?
- What about in public settings?

*Not sure if I want to go there…but maybe ask about knowledge of building codes….*

***Member checking:*** The participants' responses are summarized and read back to them. They are invited to make changes, add information, or clarify their contributions.

**Closing:** Is there anything we missed or anything anyone in the group would like to add? Do you have any final questions or comments? Thank you all for your time and contribution to this research project and the session is closed.

## Author Contributions

Amrin Ahmed: Conceptualization, Methodology, Data collection, writing – original draft, formal analysis, writing – review and editing. Alixe Menard: Writing – review and editing. Alison Novak: Writing – review and editing. Nancy Edwards: Writing – review and editing. Sarah Fraser - Conceptualization, Methodology, Data collection, formal analysis, writing – review and editing. All authors have read and approved the published version of the manuscript.

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## Competing Interests

The authors have declared that no competing interests exist.

## Additional Materials

The following additional materials are uploaded at the page of this paper.

Supplemental material: Presentation slides for the Safer Steps App.

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