ORIGINAL RESEARCH

Fall Risk Identification with Innovative Technologies for Aging in Place: A Clinical Needs Assessment Study

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ABSTRACT

Background

Falls are a leading cause of injury and loss of independence among older adults. While gait-monitoring technologies offer promise for early fall risk detection, adoption is hindered by usability, cost, and integration challenges. Few studies incorporate perspectives from both patients and providers to inform user-centred design.

Objective

To identify barriers, facilitators, and design considerations for implementing gait-monitoring and fall-assessment technologies among older adults, caregivers, and healthcare providers.

Methods

A qualitative needs assessment was conducted with older adults (≥65 years), caregivers, and healthcare providers in British Columbia, Canada. Participants were recruited via REACH BC, community organizations, and professional networks. Data collection included demographic surveys, standardized questionnaires (EuroQol 5-Dimension 5-Level (EQ-5D-5L), Patient Activation Measure (PAM-13), Fall Efficacy Scale), and semi-structured interviews. Thematic analysis was performed using NVivo 12.

Results

Twenty-nine older adults/caregivers participated. Most reported slight-to-moderate functional limitations and high engagement in self-care. Four key themes emerged: (i) navigating health and fall prevention—proactive self-management but access barriers; (ii) embracing and questioning health technologies—interest tempered by complexity and perceived relevance; (iii) openness to gait monitoring and boundaries of trust—conditional acceptance, privacy concerns; (iv) designing for real lives—preferences for comfortable, discreet, affordable devices and integration into clinical workflows. Providers valued continuous data but cited cost, patient tech-readiness, and actionable output as critical.

Conclusion

Stakeholders expressed interest in gait-monitoring technologies that are affordable, discreet, easy to use, and respectful of autonomy. Aligning device design with both personal comfort and clinical utility, and addressing privacy and integration challenges, may improve adoption and support safe aging in place.

Key words: fall assessment, aging in place, gait monitoring, multi-sensor monitoring technology, digital health, health technology adoption

INTRODUCTION

The global aging population is rapidly increasing, with estimates suggesting that by 2030, one in six people will be aged 60 years or over, placing a strain on the healthcare system and resources.[1] This demographic shift highlights a gap: conventional healthcare infrastructures are becoming less equipped to support the unique, long-term needs of older adults, who wish to age in place, that is, remaining in their homes while maintaining safety, autonomy, and quality of life.[2,3] Falls are a leading cause of injury and loss of independence among older adults, making fall prevention a central concern for aging-in-place strategies.

Technological advancements have led to the development of digital health tools, such as wearable sensors, insole systems,

and smart environments, that enable fall detection, gait monitoring, and early identification of mobility risks.[4-7] Unlike traditional fall risk assessments such as the Timed Up and Go (TUG), gait speed, and the Short Physical Performance Battery (SPPB), which provide point-in-time evaluations in clinical settings, digital health tools offer the potential for continuous, real-world monitoring of mobility patterns. This may enable the detection of subtle changes in function over time that may not be captured during episodic clinical visits. These devices provide objective measurements, including stride length, stride time, and walking speed, allowing healthcare professionals to monitor disease progression and assess the effectiveness of interventions. Importantly, these technologies are not intended to replace established clinical assessments, but rather to complement them by extending monitoring beyond the clinic and into daily life.

While these innovations hold promise, uptake remains limited due to barriers including usability concerns, cost and perceived value relative to existing low-cost clinical assessment method, stigma, and lack of integration with daily routines and clinical workflows.[8-12] Also, the needs and preferences of older adults, caregivers, and health professionals are often underrepresented in the design and implementation of such systems.

Although prior studies have explored factors affecting technology acceptance in older adults,[8,9] few have combined both patient and provider perspectives to inform a user-centred system for real-time fall risk assessment. There remains a critical gap in understanding the clinical, functional, and psychosocial considerations that influence adoption, particularly in the context of multi-sensor monitoring solutions. This study addresses this gap by exploring stakeholder perspectives to inform the development and implementation of gait-monitoring and fall-assessment technologies in support of aging in place.

Objective

This study aims to conduct a qualitative clinical needs assessment to identify barriers, facilitators, and design considerations for implementing gait-monitoring and fall-assessment technologies among older adults, caregivers, and healthcare providers.

METHODS

Study Design

We conducted semi-structured key informant interviews of a convenience sample comprising healthcare providers and older adults and their caregivers residing in British Columbia, Canada. Our findings were reported following the Consolidated Criteria for Reporting Qualitative Research.[13]

Sampling and Recruitment

Patient participants were primarily recruited through two methods: (i) REACH BC, a publicly funded, province-wide digital platform for participant recruitment,[14] and (ii) referrals via partnerships with the Unique Get Together Society, a senior community centre organization as well as healthcare providers. Healthcare professionals were similarly recruited either through REACH BC or word of mouth.

To be eligible, participants had to meet one of the following criteria: be an older adult aged 65 years or older, a caregiver for older adult(s) living at home or in care homes, or a healthcare professional. Individuals with prior fall experiences, chronic conditions, or from diverse backgrounds (e.g., Indigenous, Chinese, South Asian) were especially encouraged to participate.

Participants were excluded if they were unable to read or understand English. Individuals who expressed interest were first invited to participate in an initial consent discussion via e-mail, during which they could ask questions and receive detailed study information. Electronic informed consent was obtained following this discussion.

Data Collection

Patient participants and their caregivers were invited to carry out two activities: (i) fill out a survey to assess their demographics and current state of wellness; and (ii) participate in a key informant interview using semi-structured questions. Health professional participants were invited to take part in a key informant interview, aimed at exploring their perspectives on the use of gait-monitoring technology to support patients.

Patient participants completed surveys to capture the demographic and care context, as well as the standardized questionnaires: EuroQol 5-Dimension 5-Level (EQ-5D-5L),[15] the Patient Activation Measure (PAM 13),[16] and the Fall Efficacy Scale (FES).[17] The EQ-5D-5L is a tool developed to assess an individual's quality of life based on a self-reported outcome measure assessing five dimensions. The PAM-13 is a 13-item survey that assesses an individual's knowledge, skills, and confidence integral to managing one's own health and healthcare. The FES is a 16-item questionnaire that measures an individual's confidence in performing everyday activities without falling. The scale is designed to evaluate the fear of falling and its impact on an individual's daily life. All statements on the surveys were assessed on a 4-point Likert scale ranging from strongly disagree to strongly agree.

Then, all participants (patients, caregivers, and healthcare providers) underwent an individual interview. Each interview session lasted 45–60 minutes. A trained qualitative researcher led the interviews using an interview guide (see Figures A1–A3, Appendix A) designed based on the study's goals and existing literature on similar populations. Older adults/caregivers and healthcare providers had slightly different questions, but they focused on similar topics. The healthcare providers' questions centred on how the system could improve patient management. While the interviews were structured with core and follow-up questions, organic discussions were encouraged to gain further insights and

clarity on specific ideas. Interviews were conducted virtually on Zoom (Zoom Video Communications, San Jose, CA) or over the telephone.

Data Processing and Analysis

All interviews were conducted virtually via phone or Zoom and were audio-recorded with participant consent. Recordings were transcribed using automatic transcription software, and transcripts were subsequently reviewed and verified for accuracy by a member of the research team. Any errors or gaps in the automated transcripts were corrected through manual transcription.

Data were analyzed using thematic analysis. Two researchers independently reviewed the transcripts to familiarize themselves with the content and then generated preliminary codes using NVivo 12 (QSR International Pty Ltd, Melbourne, Australia). Coding was conducted iteratively, with frequent discussions to compare interpretations and ensure consistency. An initial coding framework was developed collaboratively and refined through team discussions, resulting in the creation of a master codebook. This final codebook was then applied systematically across all transcripts. Themes were derived inductively from the data, capturing both shared experiences and divergent perspectives across older adults, caregivers, and healthcare providers.

Ethics Approval and Informed Consent

This study was reviewed and approved by the University of British Columbia—Clinical Research Ethics Board (Protocol ID: H23-04107). All participants received written information about the study and provided informed consent before participation.

RESULTS

General Demographics

A total of 29 older adults and caregivers participated. Their age ranged from 65 years to 81+ years, with most between 65 and 70 years, with 2 less than 65 years old. All participants spoke English, and most (34.5%) identified as Caucasian. The majority of participants (86.4%) resided in a city, with a few individuals participating from rural regions. The majority of adults lived alone at home (41.4%) or with a partner (41.4%). The distance from the nearest hospital/clinic ranged from less than 1 km to over 50 km for participants. Table 1 provides a summary of the demographics.

Out of the four healthcare providers that participated, one was a gerontologist, one was a nurse, and two were physiotherapists. Their years of practice ranged from 1 to 30 years, with each category (1–10 years, 10–20 years, 21–30 years) represented equally, and one participant not specifying their years of practice. The nurse worked in a mental health facility, and the physiotherapists worked in various outpatient clinic settings.

TABLE 1.
Demographics of older adult participants (n = 29)

Demographics	*N (%)*
Age	
55–60	1 (3.4)
60–65	1 (3.4)
66–70	13 (44.8)
71–75	4 (13.8)
76–80	3 (10.3)
81+	7 (24.1)
Gender	
Female	20 (68.9)
Male	9 (31.1)
Location	
Greater Vancouver	11 (37.9)
Vancouver	1 (3.4)
Coquitlam	1 (3.4)
Richmond	3 (10.3)
Surrey	1 (3.4)
West Vancouver	1 (3.4)
North Vancouver	1 (3.4)
Vancouver Island	
Courtenay	1 (3.4)
Victoria	6 (20.7)
Fraser Valley	
Chilliwack	1 (3.4)
Interior BC	
Kelowna	1 (3.4)
Kamloops	1 (3.4)
Language	
English	29 (100)
French	1 (3.4)
Mandarin	1 (3.4)
Cantonese	1 (3.4)
Spanish	1 (3.4)
Japanese	1 (3.4)
German	1 (3.4)
Ethnicity	
Caucasian	10 (34.5)
Canadian	3 (10.3)
Chinese	3 (10.3)
European	6 (20.7)
African American	6 (20.7)
Prefer not to answer	1 (3.4)
Living arrangement	
Alone at home	12 (41.4)
Home with partner and/or children	12 (41.4)
Home with someone else	1 (3.4)
Home with caregiver	1 (3.4)
Home with other older adults	1 (3.4)
Senior complex	1 (3.4)
Prefer not to answer	1 (3.4)

Questionnaires

Through the EQ-5D-5L, we found that older adults had slight to moderate problems in one or more domains

(mobility, self-care, usual activities, pain/discomfort, anxiety, or depression).

Through the 13 statements of the PAM, we found that older adults were very engaged in their healthcare with most (95%) responding "agree strongly" or "agree" to statements such as "I know what each of my prescribed medications do" or "Taking an active role in my own healthcare is the most important thing that affects my health."

Through the 16 statements of the FES, we observed that most older adults were confident in performing everyday activities without fear of falling. However, tasks such as "walking on a slippery surface" and "walking on an uneven surface" stood out, with participants predominantly expressing responses such as "somewhat concerned" or "very concerned". The full breakdown of the responses can be found in Figures A1–A3, Appendix A.

Interviews

We organized the interview findings into four overarching themes, each comprising several sub-themes. These themes reflect the lived experiences of older adults in managing their health and preventing falls, as well as healthcare providers' insights on clinical integration of the gait-monitoring technology. Table 2 provides a summary of each theme and sub-themes, along with brief descriptions and representative quotes that illustrate the core ideas.

Theme 1: Navigating Health and Fall Prevention

Healthcare Access and Advocacy

Most older adult participants were actively engaged with the healthcare system, regularly seeing family doctors and specialists. However, access was not always seamless. For some, mobility challenges, distance, or dependence on others for transportation made it difficult to attend appointments. Beyond physical barriers, several older adults and caregivers described feeling unheard during consultations, prompting them to advocate persistently for their needs.

Fall Prevention As a Way of Life

Older adult participants were deeply invested in maintaining their physical independence; together with their caregivers, they often integrated fall prevention strategies into their daily routines. Activities like housework and walking were more than chores; they were deliberate actions to maintain mobility. Many also modified their living environments to reduce fall risks, demonstrating resourcefulness and determination. For some, this included installing railings, improving lighting, or wearing non-slip footwear. These changes reflect a proactive and practical approach to aging safely at home.

Theme 2: Embracing and Questioning Health Technologies

Perceptions of Everyday Health Tech

Participants (older adults and caregivers) demonstrated mixed relationships with health technology. While a small proportion remained skeptical, the majority reported using or valuing tools like Fitbits, telemedicine platforms, or apps for medication and fitness tracking. Those who adopted these technologies found them beneficial for promoting independence and enhancing awareness of their health metrics. Yet, others found these tools as burdensome, citing factors such as forgetfulness, technical challenges, or a lack of perceived relevance. This ambivalence suggests that the successful adoption of health technology depends not only on access but also on personal fitness, habits, and perceived usefulness.

Remote Monitoring Awareness and Limitations

Wearable health technologies were widely embraced for tracking basic metrics like steps and heart rate, but many participants (older adults and caregivers) were unaware of more advanced capabilities such as gait monitoring. For most, wearable devices served as general motivators to stay active rather than targeted tools for clinical insight. This knowledge gap points to a missed opportunity for deeper engagement with preventive health technologies. While they were open to learning more, many had never been introduced to features beyond the basics.

Theme 3: Openness to Gait Monitoring and Boundaries of Trust

Conditional Acceptance of Gait Monitoring

Older adults generally expressed interest in using gait-monitoring devices, particularly those who had experienced or feared falling. The perceived benefits of early detection and prevention often outweigh the concerns about learning new technology. However, this willingness came with limits as some worried about the cognitive load of managing additional devices, especially when they were already struggling with existing ones. Others emphasized the importance of autonomy in decision-making, wanting to ensure that they, and not family members or clinicians, would determine when to adopt new technology.

Data Sharing: Support Versus Surveillance

Participants, both older adults and caregivers, held divergent views on who should have access to gait data. Many supported sharing with family or healthcare providers for safety and early intervention. Others worried about losing privacy or becoming overly scrutinized. The concept of being monitored continuously, especially if it was not fully within their control, raised concerns about surveillance and autonomy. For some, self-monitoring was sufficient, and involving others felt intrusive unless a problem had already been identified.

Theme 4: Designing for Real Lives: Barriers and Opportunities

User-Centred Design Priorities

Comfort, simplicity, and discretion emerged as key priorities in participants' preferences. Wearable devices that resembled everyday items, such as watches or jewellery, were far more acceptable than those perceived as bulky or attention-drawing.

TABLE 2.
Summary of themes and sub-themes

Theme	*Sub-Theme*	*Description*	*Illustrative Quotes*
1. Navigating Health and Fall Prevention	1.1 Healthcare Access and Advocacy	While most participants accessed healthcare regularly, some faced barriers due to mobility, distance, or feeling unheard by providers.	"I don't see my doctor as often because I can't get there on my own."—Older adult "Sometimes I have to complain repeatedly before I get what I need."—Older adult
	1.2 Fall Prevention as a Way of Life	Participants took proactive steps—like home modifications, staying active, and managing diet and medications—to prevent falls and preserve independence.	"I make sure to stay active by doing my own housework and taking short walks every day."—Older adult "I switched to non-slip shoes after a fall scare, and it's made a big difference."—Older adult
2. Embracing and Questioning Health Technologies	2.1 Perceptions of Everyday Health Tech	Most used or appreciated health technologies but some struggled with use due to forgetfulness, complexity, or perceived irrelevance.	"Telemedicine allows me to live independently while still keeping a close eye on my health."—Older adult "I often forget to use the devices I have; it just doesn't fit into my routine."—Older adult
	2.2 Remote Monitoring Awareness and Limitations	Participants commonly used wearables for basic tracking but were largely unaware of advanced features like gait monitoring.	"My Apple Watch is great for checking my heart rate."—Older adult "I didn't realize my watch could monitor my gait—I've only used it for steps and heart rate."—Older adult
3. Openness to Gait Monitoring and Boundaries of Trust	3.1 Conditional Acceptance of Gait Monitoring	Many were open to gait monitoring, particularly if fall prevention was a concern, but wanted autonomy and simplicity.	"If using a gait monitor can help prevent a fall, I'm willing to give it a try."—Older adult "It's my choice to use it or not, and I'll only do so if I think it's really necessary."—Older adult
	3.2 Data Sharing: Support vs Surveillance	Opinions varied on sharing data; some saw benefits, others were concerned about privacy or unwanted oversight.	"Sharing the information with my family gives them peace of mind."—Older adult "I'm okay with monitoring my own data, but I'm not sure I want to involve others."—Older adult
4. Designing for Real Lives: Barriers and Opportunities	4.1 User-Centred Design Priorities	Comfort, discretion, simplicity, and accessibility were key design factors; participants favoured wearable or familiar formats.	"If I'm going to wear something all day, it needs to be comfortable."—Older adult "If it requires a lot of setup or technical know-how, I'm probably not going to use it."—Caregiver
	4.2 Clinical Utility and Integration	Providers valued continuous monitoring and trend data but noted challenges with clinical integration, cost, and patient tech-readiness.	"You might see a patient on a good day, but the wearable could pick up subtle changes over time."—Healthcare provider "Having the data in a clear, graphical format would be really helpful."—Healthcare provider

Concerns about stigmatization and physical discomfort were particularly prominent. All participants (older adults, caregivers and healthcare providers) also preferred devices that were intuitive to use, requiring minimal setup or maintenance. While features such as voice activation or Bluetooth syncing were of interest, participants emphasized that these should not add complexity to the user experience.

Clinical Utility and Integration

Both older adults and healthcare providers recognized the potential of gait-monitoring devices to enhance clinical care by offering continuous, contextualized data. Providers saw value in tracking changes over time to inform treatment decisions. They also emphasized the importance of integrating data into existing systems in formats that are easy to interpret. However, concerns about cost, patient tech literacy, and added clinical workload were noted as potential barriers to adoption. Providers stressed that unless the data led to actionable insights without burdening the clinical workflow, it would be difficult to justify routine use.

DISCUSSION

This study explored the perspectives of older adults, caregivers, and healthcare providers on the use and design of gait-monitoring technologies to support aging in place. Our findings highlight that while there is general openness

to digital health tools, their adoption is highly conditional, shaped by perceived usefulness, ease of use, cost, and alignment with users' daily routines and values. Across all stakeholder groups, there was a shared emphasis on the need for technologies that are low-burden, actionable, and respectful of autonomy and privacy.

Importantly, our findings suggest that digital health tools should be positioned as complementary rather than alternatives to existing fall risk assessment methods. While traditional tools such as the TUG, gait speed, and the SPPB remain essential for rapid clinical screening, participants and healthcare providers identified a gap in capturing real-world, longitudinal changes in mobility. Continuous monitoring was perceived as particularly valuable for identifying subtle functional decline and informing earlier interventions, especially in between clinical encounters. This highlights a key opportunity for digital tools to enhance, not replace, current care pathways.

Perceived value and practicality emerged as important considerations influencing adoption. Participants and healthcare providers emphasized that technologies must be easy to use, minimally burdensome, and clearly beneficial to justify their integration into daily life and clinical practice. While cost-effectiveness was not directly explored in this study, it remains an important consideration for future research evaluating the broader implementation of these technologies.

While prior studies have identified barriers to the adoption of fall-monitoring technologies, including usability challenges, stigma, cost, and privacy concerns,[8,11,12] our findings provide deeper insight into how these barriers are experienced and negotiated in real-world contexts across multiple stakeholder groups. Older adults emphasized the importance of discreet, comfortable devices that integrate seamlessly into daily life, while healthcare providers highlighted the need for data that are actionable and easily incorporated into clinical workflows. Providers also highlighted minimizing patient burden and designing technologies that account for cognitive impairments, consistent with the user-centric principles often recommended in geriatric care.[18] Rather than identifying entirely new barriers, our study advances the field by clarifying how these factors interact to shape conditional acceptance, where adoption depends on perceived relevance, ease of use, and alignment with individual values and routines. These findings reinforce the importance of user-centred and co-designed approaches to ensure that technological innovation translates into meaningful, real-world use.

A novel contribution of this study is the identification of a "dual burden" of technology adoption, wherein both patients and healthcare providers experience added demands, patients in using and maintaining devices, and providers in interpreting and acting on data. This finding shows the importance of designing systems that minimize burdens on both ends, ensuring that technological benefits do not come at the cost of usability or clinical efficiency.

Privacy and data-sharing preferences also emerged as critical considerations. While some participants valued sharing data with caregivers and healthcare providers for safety and reassurance, others expressed concerns about surveillance and loss of autonomy. These findings highlight the need for flexible, user-controlled data-sharing models that can adapt to individual preferences and levels of trust.

Novel Contributions of This Study

Building on these findings, this study makes several novel contributions: (i) triangulating perspectives from older adults, caregivers, and healthcare providers to align needs and identify shared priorities (e.g., affordability, comfort, data control); (ii) revealing interest in predictive features such as trend detection and risk stratification; and (iii) introducing the concept of "dual burden," where technology places demands on both patients (use) and providers (interpretation), underscoring the need for low-friction designs.

Limitations

Findings are based on a sample of relatively healthy, urban, English-speaking older adults, which may not reflect the perspectives of rural, more impaired, or non-English-speaking populations. While ethnically diverse participants were included, representation was insufficient to explore cultural differences. Future studies should use purposive sampling to better capture underrepresented groups.

Additionally, the use of convenience sampling may have resulted in the inclusion of participants who are more engaged with their health and the healthcare system, potentially limiting the transferability of findings to less-engaged or more vulnerable populations.

CONCLUSION

This needs assessment highlights a shared preference for gait-monitoring technologies that are functional, low-burden, and respectful of autonomy. Adoption was linked to affordability, privacy, comfort, and predictive capabilities. These findings provide actionable guidance for co-developing next-generation tools to support aging in place.

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CONFLICT OF INTEREST DISCLOSURES

We have read and understood the *Canadian Geriatrics Journal's* policy on conflicts of interest disclosure and declare that we have none.

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APPENDIX A. Breakdown of questionnaire responses

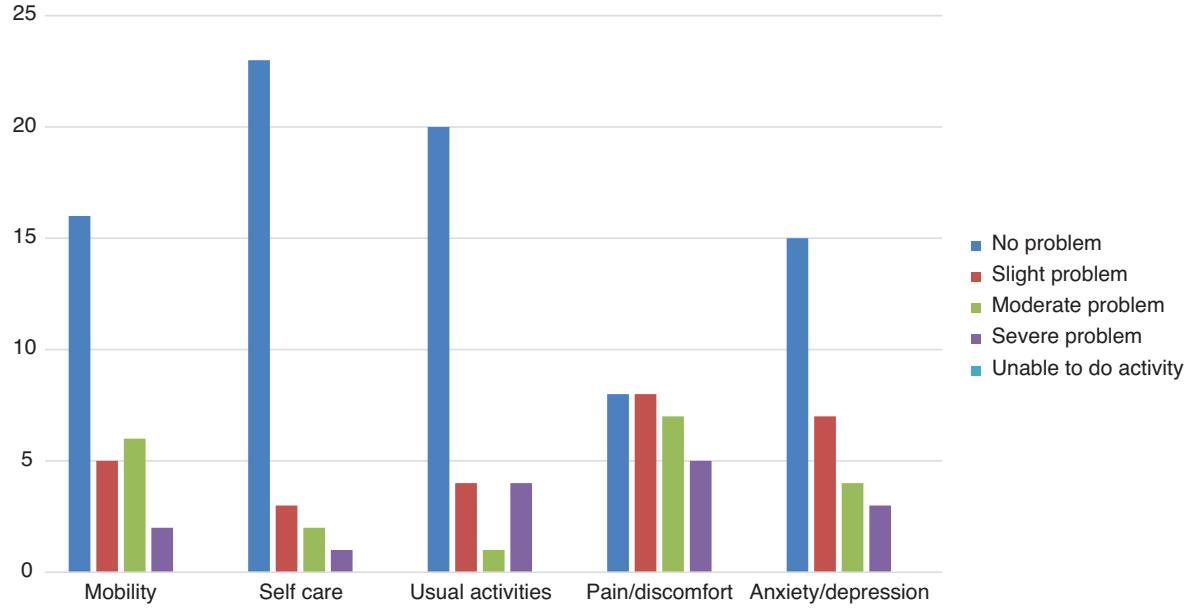

FIGURE A1. EuroQol 5-Dimension 5-Level (EQ-5D-5L) response frequencies by domain

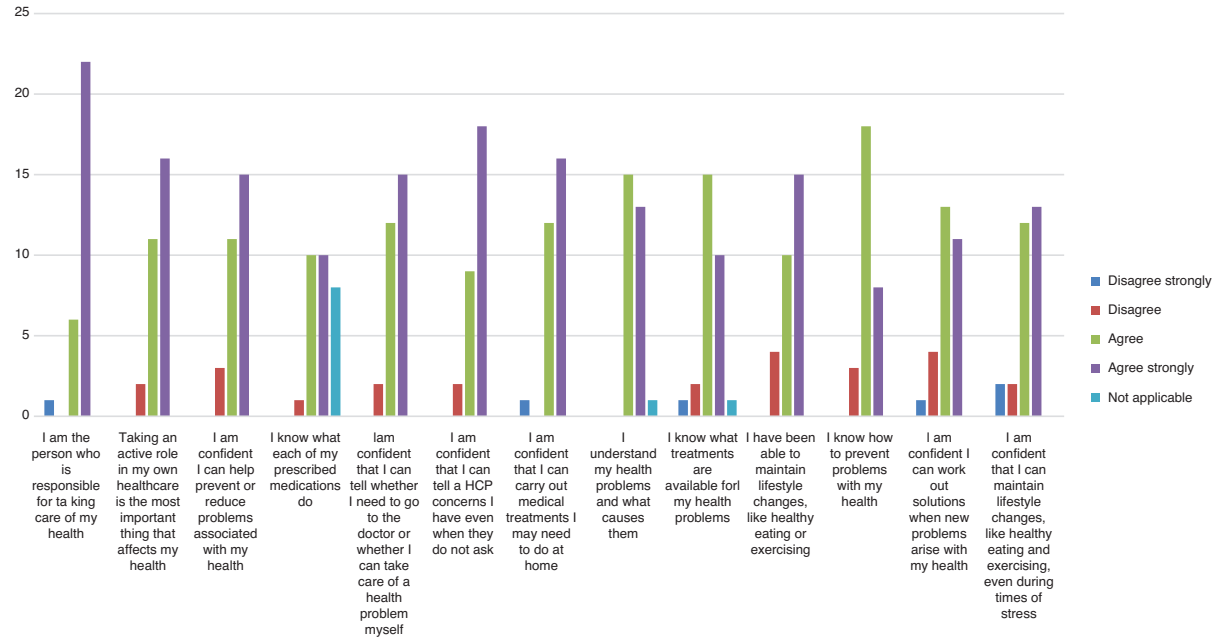

FIGURE A2. Patient Activation Measure (PAM-13) statement frequency breakdown. HCP, healthcare provider

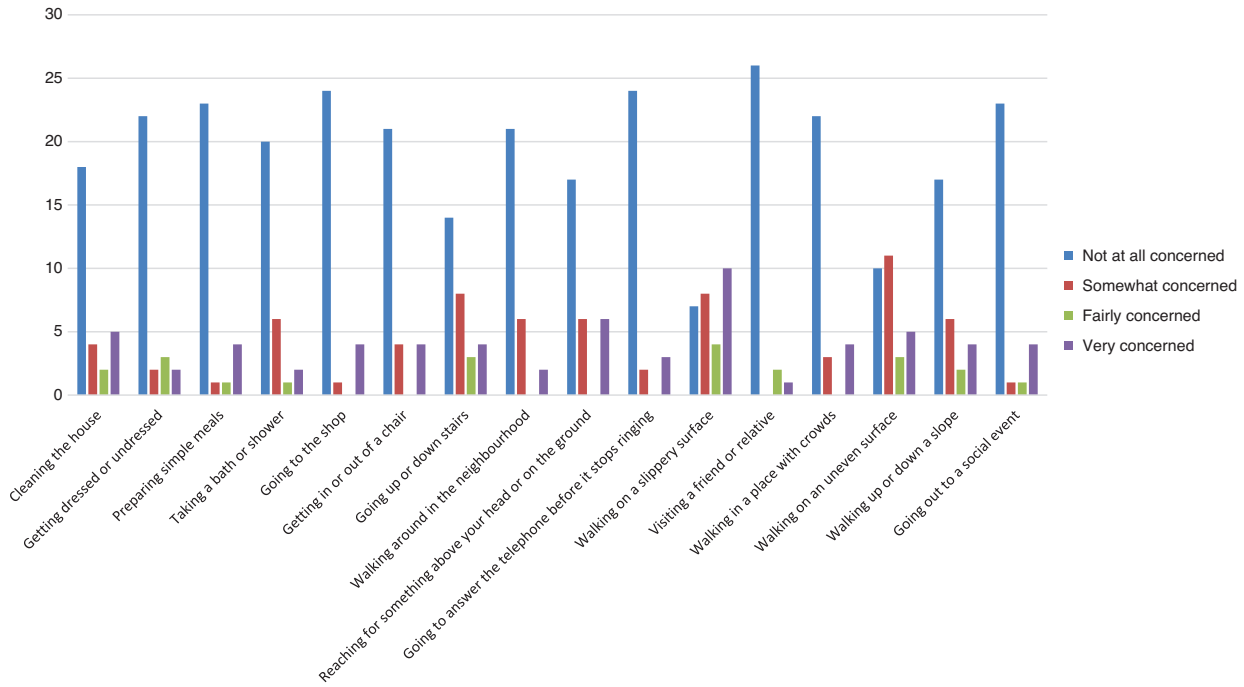

FIGURE A3. Fall Efficacy Scale (FES) breakdown