

Experiences of Individuals Living with Dementia, Caregivers, and Service Providers regarding Independence-Enhancing Technologies: Focus Group Insights

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Abstract

This study explored the views and opinions of individuals living with dementia, caregivers, and healthcare professionals on assistive technologies that facilitate independent living. Using a qualitative approach, the researchers conducted focus groups with 35 participants in England. Findings revealed both the benefits and limitations of technologies like medication management devices, activities of daily living aids, GPS tracking, and smart home systems. While participants recognized the potential to enhance independence and safety, they highlighted usability, reliability, and technological failure as significant challenges. The complexity of digital interfaces and the cognitive demands of online interactions emerged as key barriers. Participants expressed a strong desire for more adaptive, user-friendly, and responsive technologies. The study underscores the importance of user-centered design and collaboration between developers, caregivers, and people living with dementia. By addressing the identified issues, future assistive technologies can improve quality of life for individuals living with dementia and their caregivers. These insights can guide the development of more effective, accessible, and ethical assistive technologies in dementia care.

Keywords: Dementia; Assistive technologies; Independent living; User-centred design; Digital accessibility

Introduction

The global demographic landscape is undergoing a significant transformation, with the aging population in developed regions growing at an unprecedented rate. Projections indicate that by 2050, approximately one-third of the population in these areas will be aged 60 years and over (World Health Organisation, 2012). This shift is accompanied by a substantial increase in the prevalence of dementia, with estimates suggesting a rise from about 47 million cases today to over 130 million by 2050 (Prince et al., 2015). Recent data from the World Health Organization (2021) estimates that 55 million people globally live with dementia, with a new case emerging every three seconds. This highlights the urgent need for prevention, potential cures, and enhanced care and support for **individuals living with dementia** and their caregivers. Increased longevity, while a societal achievement, raises concerns about intergenerational burdens (Phillipson & Baars, 2007). Aging is often accompanied by chronic conditions and functional decline (Phillips et al., 2010). Dementia, characterized by an unpredictable, multi-year trajectory (Department of Health, 2009), shows variable survival rates based on diagnosis timing (Fleisher & Corey-Bloom, 2010; Rait et al., 2010), dependant on factors like cognitive reserve and early interventions (Livingston et al., 2020). The financial impact of dementia remains substantial and increasing. In the United Kingdom, the cost of dementia care has risen to £34.7 billion annually (Alzheimer's Society, 2019), while global costs have escalated to an estimated US\$1.3 trillion in 2019 and are projected to surpass US\$2.8 trillion by 2030 (Alzheimer's Disease International, 2020). These figures underscore the urgent need for cost-effective interventions and support systems.

Most individuals living with dementia have additional health conditions (National Audit Office, 2007), presenting complex physical and psychological needs as the disease progresses (Duong et al., 2017; Grande et al., 2020). Addressing these complex needs through technological tools that promote independence has become an increasingly important area of research (e.g., Bauernschmidt et al., 2024; Kirby et al., 2024; Klöppel et al., 2024; Koh et al., 2024; Lorenz et al., 2019). Technology continues to play a crucial role in supporting individuals living with dementia and alleviating economic burdens, aligning with strategies such as the UK National Health Service Long Term Plan's Digitally Enabled Care theme (National Health Service, 2019). The evolution of technology in dementia care has been notable, advancing from basic assessment tools to comprehensive support systems for daily living. For the purposes of this study, we define "technologies for independence" as any technological tools, devices, or systems designed to support individuals living with dementia in maintaining autonomy, safety, and quality of life while reducing reliance on caregivers for routine tasks. These range from specialized dementia-focused technologies (such as medication management systems, GPS trackers, or smart home monitoring) to mainstream

technologies adapted for use by people with cognitive impairments (such as simplified smartphones, voice assistants, or video communication platforms).

Initially, technology primarily assisted in dementia assessment, exemplified by tools like the Cambridge Neuropsychological Test Automated Battery (Robbins et al., 1994). This approach has since broadened to encompass web-based and app-based cognitive assessments, including innovative methods like digital clock drawing tests (Cohen et al., 2014; Souillard-Mandar et al., 2016). The following examples illustrate the diverse directions technology is taking within the field of dementia care: advanced systems employing machine learning and data mining are utilized in dementia diagnosis through various imaging modalities, such as amyloid PET, MRI, and combined PET/MRI imaging (Dallora et al., 2017; Mathotaarachchi et al., 2017; Cheng et al., 2015; Liu et al., 2015); significant progress has also been made in non-imaging studies, which leverage demographic and cognitive data (Bhagyashree et al., 2018), linguistic analysis (Korcovelos et al., 2017), and gait monitoring (Dodge et al., 2017) for assessing and tracking the progression of dementia; technological applications have further expanded to support everyday tasks, from simplified interfaces like one-button radios (Orpwood et al., 2010) to systems assisting with the preparation of warm beverages (Allain et al., 2014; Wherton & Monk, 2010); additionally, monitoring technologies have evolved to become increasingly sophisticated, enabling the tracking of dementia progression (Kaye et al., 2011) and providing digital prompts to help individuals maintain daily activities (Mihailidis et al., 2008). Furthermore, cognitive Assistive Technologies have paved the way for "zero effort technologies" and novel model developments, significantly impacting the field (e.g., Begum et al., 2008; Boger et al., 2018; Robillard & Hoey, 2018). Innovations in smart home technologies, which integrate sensors and AI, have been particularly noteworthy for their ability to support health monitoring (Sprint et al., 2016). These advancements include the development of self-installable systems for clinical trials, enhancing accessibility and usability (Orpwood et al., 2004; Teipel et al., 2018). Navigation technologies, especially GPS-enabled smartphones, have become invaluable in supporting safe walking for individuals living with dementia, ensuring their safety and independence (Wood & Woolham, 2015; Teipel et al., 2016).

The significance of technologies that enhance social and leisure activities has also been recognized, with specific programs designed to promote engagement in art, yielding cognitive benefits (Mihailidis et al., 2010; Leuty et al., 2013). Furthermore, virtual reality (VR) and augmented reality (AR) technologies are being actively explored for their potential in cognitive training and rehabilitation (Hayhurst, 2018). More recently, advancements include the development of AI-powered chatbots tailored for dementia care. These chatbots offer companionship, cognitive stimulation, and can even assist in the early detection of cognitive

decline (Laranjo et al., 2018). Wearable technologies have also evolved to provide continuous monitoring of vital signs and activity levels, delivering critical data to caregivers and healthcare professionals (Stavropoulos et al., 2020). Additionally, emerging research is exploring the potential of brain-computer interfaces (BCIs) in the context of dementia care, presenting new possibilities for treatment and support. These technologies aim to restore or enhance cognitive functions by directly interfacing with neural activity (Chiang et al., 2021). While still in early stages, BCIs represent a promising frontier in technology-assisted dementia care. Despite these advancements, it's important to note that this overview only scratches the surface of the technologies and tools making strides in healthcare sectors and public markets. The rapid pace of technological innovation continues to open new possibilities for supporting individuals living with dementia and their caregivers.

Implementation has been slowed by ethical concerns about privacy, autonomy, safety, and trust, as well as the risk of health-related bias and inequality (Ienca et al., 2017; Liddle et al., 2022; Birchley et al., 2017; Hine et al., 2022; Sánchez et al., 2017). Despite global technological advancements, implementation in health and care for dementia has been slow. There is a growing recognition that successful development should prioritize the individual with dementia and their support network (Hine et al., 2022; Liddle et al., 2022). This approach emphasizes the importance of integrating user perspectives into the design and adaptation of technologies. By doing so, developers can ensure that new innovations are not only effective and acceptable but also ethically sound (Liddle et al., 2022; Øksnebjerg et al., 2019). While existing literature on technology for dementia care has primarily focused on clinical effectiveness, technical feasibility, and caregiver perspectives, recent work highlights the crucial role of usability for individuals with dementia (Chien et al., 2024). Chien et al. (2024) emphasize that usability in this context extends beyond general principles of effectiveness, efficiency, and satisfaction to include adaptability, personalization, intuitiveness, and simplicity. Their findings underscore the importance of designing technology that accommodates the diverse and evolving needs of individuals with dementia, ensuring that it remains accessible and beneficial over time. However, despite these advancements, a significant gap remains regarding the personal lived experiences of individuals with dementia as they engage with various technologies. Individuals living with dementia, especially those in the early stages of the disease, should be empowered to take a more active role in managing their condition and participating in meaningful activities (e.g., Mihailidis et al., 2008). Consequently, there is a critical need to adjust pre-existing or develop new technologies tailored for individuals living with dementia, with a strong emphasis on usability and user-centred design.

Study Aims

The aim of the study was to gather and present the views and opinions of individuals living with dementia and other stakeholders regarding the use of tools and technologies that facilitate independent living for individuals living with dementia. Additionally, the study sought to explore and identify the pathways and barriers to implementing these tools and technologies within the health and care system, including their integration into homes, devices, and care services. Recognizing and responding to the complex and evolving needs of individuals is essential for researchers and technology developers in the field of dementia care. As such, the study engaged a diverse range of participants over a one-month period, including individuals living with dementia aged over 50, informal and formal caregivers, dementia charities, private service providers, and National Health Service (NHS) clinicians specializing in dementia care and treatment. This paper presents the outcomes of a focus group study conducted in England which intends to support our understanding of the role technology in enabling independence for individuals living with dementia.

Methods

Recruitment and Sampling

Purposive and snowball sampling techniques were employed to recruit participants with relevant experiences and perspectives. Recruitment was conducted through pre-existing networks involving the lead university, hospital trusts, dementia societies and local support groups, and charity organizations. Participants were recruited via word-of-mouth. Inclusion criteria required participants to be English-speaking adults with capacity to consent, and to have direct experience either living with dementia, caring for someone with dementia, or working professionally in dementia care. Individuals without capacity to consent were excluded from the study. Prior to participation, individuals received a Participant Information Leaflet (PIL) detailing the purpose of the focus groups, their ethical rights (e.g., confidentiality, anonymity, right to withdraw), and a comprehensive description of the study's intended outcomes. For individuals with dementia, researchers took additional time to review the PIL, using clear language and checking comprehension throughout. When needed, information was presented in smaller sections to facilitate understanding. All participants had the capacity to sign consent forms independently and were not asked to disclose personal information. Capacity was assessed using a process consistent with the Mental Capacity Act (2005), ensuring participants could understand, retain, and weigh information about the study, and communicate their decision. Ethical approval for the study protocol was granted by the lead institution [2324_71].

Participants

The study enlisted 35 English-speaking female ($n = 20$) and male ($n = 15$) participants, ranging from 28 to 87 years of age (M age = 62.85, $SD = 17.48$). Table 1 provides a detailed breakdown of participant demographics and roles. The participants included individuals with diverse experiences related to dementia: those with a formal diagnosis of dementia ($n = 8$, M years of cognitive impairment = 7.65 years, $SD = 4.08$), informal caregivers ($n = 14$, M experience = 5.11 years, $SD = 4.65$) and formal caregivers ($n = 7$, M experience = 13.5 years, $SD = 6.69$), and professionals working with dementia patients, including wayfinders ($n = 4$, M experience = 4.75 years, $SD = 1.92$) and medical experts ($n = 2$, M experience = 11.50 years, $SD = 2.50$). Wayfinders are specialized support workers who help individuals with dementia navigate healthcare and community services. At the time of data collection, all participants caring for people with dementia (referred henceforth as caregivers), either personally or professionally, were actively engaged in such roles. Additionally, all participants, except people living with dementia and their informal caregivers (e.g., marital partners), were currently employed. Informal caregivers were relatives or friends of people with dementia, while formal caregivers were paid professionals working in care settings.

Table 1.

Participant Demographics and Roles

Role	n	Age Range	Gender (F/M)	Years of Experience (Mean $\pm$ SD)
People with dementia (PwD)	8	65-87	3/5	7.65 $\pm$ 4.08
Informal caregivers	14	42-79	9/5	5.11 $\pm$ 4.65
Formal caregivers	7	28-56	4/3	13.5 $\pm$ 6.69
Wayfinders	4	30-45	3/1	4.75 $\pm$ 1.92
Medical experts	2	52-59	1/1	11.50 $\pm$ 2.50

Study Design and Procedure

The focus groups were conducted between June and July 2024 in convenient locations such as support services buildings or the lead university with appropriate transport links. Sessions took place in quiet, distraction-free rooms and were audio-recorded using a Zoom H1n Portable Recorder. Participants were assigned to groups (labelled A, B, C, and D) based

on availability rather than demographic matching. Session sizes were designed to be small enough to allow all participants to contribute meaningfully while large enough to generate diverse perspectives (Morgan, 1997). Attendance was robust across all groups: A ($n = 9$), B ($n = 11$), C ($n = 11$), and D ($n = 4$). There were no non-attendance issues, and no participants attended multiple sessions. Seven days before the sessions, participants received study information and reminders about voluntary participation. The information was provided in accessible formats, with simplified versions available for people with dementia. Snowball sampling was employed to increase the sample size. At the meetings, participants were provided an additional copy of the information sheets and consent forms. The project team allocated time to explain proceedings, answer questions, and allow for review and signing of consent forms. Facilitators were trained to support people with dementia through the consent process, using simplified explanations and checking understanding throughout. Confidentiality was assured, with the use of aliases for any direct quotes. Although optional, all participants completed demographic sheets detailing age, gender, and, for people living with dementia, an estimate of years experiencing memory issues. No compensation was offered for participation, which may have affected recruitment but ensured voluntary engagement.

Each 45-minute focus group was led by a facilitator (the lead researcher) with a researcher present to take notes and document seating arrangements. The facilitator was experienced in conducting focus groups with vulnerable populations and was trained to create an inclusive environment where all participants could contribute. For efficient note-keeping, aliases were pre-assigned to participants' chairs. The facilitator began by outlining the grant application focused on developing technologies to enable independence for people living with dementia. The discussion was then opened for participant-driven, open-ended conversation without direct questioning from the facilitator. The facilitator's role was to guide discussions, ensure all participants had opportunities to contribute, and sensitively redirect conversations, when necessary, while avoiding leading questions. Follow-up prompts were used to explore emerging themes in greater depth. The facilitator was particularly attentive to supporting people with dementia to express their views, allowing additional time and using communication strategies appropriate for individuals with cognitive impairment. The aim was to foster a safe, open, and transparent dialogue among participants, who were not asked or expected to disclose personal information. While the groups were mixed (including PwD, caregivers, and professionals), the facilitator ensured that power dynamics were managed carefully, with specific attention to amplifying the voices of people with dementia. Following each focus group, participants were debriefed and given an opportunity to provide additional comments. They were then thanked for their time and contributions.

Methodology

The study employed a critical realist epistemology, acknowledging that while data can reveal aspects of participants' reality, interpretation is necessary to uncover deeper meanings (Willig, 2001). This approach recognizes that participants' subjective experiences of living independently with dementia offer valuable but partial insights into their reality. Critical realism posits that an objective reality exists, but our understanding of it is mediated by our perceptions and social contexts (Bhaskar, 1978). As such, researchers must engage in interpretative activities to comprehend the full complexity of participants' experiences, while remaining aware of their own role in knowledge construction (Maxwell, 2012). The focus group methodology was selected as it allows for dynamic interaction between participants, generating rich data through shared experiences and diverse perspectives (Kitzinger, 1995). This approach is particularly valuable when exploring complex topics such as technology use in dementia care, where individual experiences and group dynamics can reveal nuanced insights that might not emerge in individual interviews.

Analysis Strategy

The analysis followed a systematic three-phase process combining qualitative and quantitative approaches to provide a comprehensive understanding of the data. This three-phase approach aligns with Braun and Clarke's (2022) reflexive thematic analysis framework, which emphasizes researcher reflexivity, organic coding processes, and the evolving nature of theme development rather than rigid adherence to prescriptive steps. The coding process involved two researchers (BS and EO) independently coding the data. Following Braun and Clarke's (2022) approach, we began with data immersion through repeated readings of transcripts, followed by systematic inductive coding where initial codes emerged organically from the data rather than from predetermined frameworks. The researchers met regularly throughout this process to discuss emerging codes, share interpretations, and reflect on how their own positionalities might influence their reading of the data. The second phase involved theme development, where researchers collaboratively identified patterns across codes and organized them into potential themes. This was an iterative process involving revisiting the data, refining themes, and creating thematic maps to visualize relationships between themes. Themes were then reviewed against the coded extracts and the entire dataset to ensure they meaningfully captured participants' experiences. The final phase of defining and naming themes involved precisely articulating the essence of each theme and situating it within the broader narrative about assistive technologies for dementia. Initial codes were developed inductively from the raw data and then grouped into broader themes through an iterative process of discussion and refinement. When disagreements in coding or theme development occurred, researchers engaged in reflexive dialogue, revisiting the original data together until consensus was reached. This approach prioritized interpretative depth over simple inter-rater

reliability, consistent with Braun and Clarke's reflexive thematic analysis principles. NVivo 12 software was used to organize and manage the coding process.

To enhance analytical rigor and provide additional perspectives on the data, we supplemented the qualitative thematic analysis with quantitative approaches. Frequency analysis was adopted specifically to quantify the occurrence of key themes (Namey et al., 2008; Srnka & Koeszegi, 2007). This approach complemented the qualitative analysis by providing a quantitative measure of the prevalence and distribution of themes across participant groups, offering insight into which aspects of technology use were most salient to different stakeholders. Finally, a sentiment analysis was conducted to gauge the emotional tone of participants' responses (Mohammad, 2020; Liu, 2020; Tausczik and Pennebaker, 2010). This sentiment analysis involved using natural language processing software (Amazon Comprehend, 2024), to categorize sentiments and calculate overall sentiment scores for each theme (Ribeiro et al., 2016; Ritchie et al., 2021).

This mixed-methods approach allowed us to not only identify what participants said about technologies but also how they felt about them, providing a more holistic understanding of their experiences. The sentiment analysis specifically helped identify technologies that elicited strong positive or negative emotional responses, offering valuable insights for future development priorities. To ensure trustworthiness of the analysis, we employed several strategies. First, we maintained detailed audit trails documenting analytical decisions throughout the research process. Second, we engaged in peer debriefing, where preliminary findings were discussed with colleagues knowledgeable about dementia care but not involved in the study. Third, multiple researchers analysed the same data. Finally, we conducted member checking with a subset of participants ($n = 5$) from different stakeholder groups, sharing preliminary themes and soliciting feedback on whether our interpretations resonated with their experiences. By combining these analytical approaches, we aimed to provide a nuanced understanding of both the content and emotional context of participants' responses, while also quantifying the prevalence of key themes, ensuring our methodology is grounded in well-established qualitative and quantitative research practices.

Reflexive Statement

As researchers, we acknowledge our active role in shaping the outcomes of this study. The primary coder (BS) and secondary coder (EO) who were involved in the thematic analysis both have experience as researchers in the field of dementia. As cognitive psychologists and neuroscientists, they have conducted evaluations of dementia services and are actively leading the development of specialized cognitive training technologies for individuals living with mild cognitive impairment. Our positionality as researchers with expertise in both

dementia care and technology development may have influenced our interpretation of the data. We approached the analysis with awareness of current technological solutions and their limitations, which could have shaped our identification of themes related to technology usability and accessibility. Additionally, our professional background in cognitive psychology may have heightened our attention to issues related to cognitive demands of technology use. Throughout the analysis process, we engaged in regular reflective discussions to examine how our own perspectives, assumptions, and biases might be influencing our interpretations. We maintained reflexive journals documenting our thought processes and decisions, which helped us to remain conscious of our active role in knowledge construction.

We recognize that our position as academic researchers may have created power dynamics within the research process, particularly in relation to participants with dementia. We sought to mitigate this by prioritizing the voices of people with dementia during both data collection and analysis, and by critically examining our interpretations for potential bias. Adhering to the principles of reflexive thematic analysis (Braun et al., 2022), we recognize the significance of our professional backgrounds and personal experiences in informing the identification of key themes and patterns within the data. Throughout the analysis process, we engaged in ongoing reflection to examine how our own perspectives and biases may have shaped the interpretations and findings. By explicitly acknowledging our active role as researchers, we aim to enhance the transparency and trustworthiness of the analytical process and its outcomes.

Results

Summary

The analysis revealed both the benefits and challenges of assistive technologies for individuals with dementia and their caregivers. Key themes included the empowerment provided by assistive devices, frustrations with unreliable and complex technologies, and a strong desire for adaptive, user-friendly innovations. While medication management and emergency response devices enhanced independence and security, usability issues in voice-activated assistants, GPS wearables, and digital interfaces often led to frustration. Additionally, participants expressed a preference for in-person social interactions over digital alternatives. Frequency and sentiment analyses highlighted the prevalence of these concerns and the emotional responses to technological interventions, underscoring the need for more intuitive and responsive solutions.

Thematic Analysis

Theme 1: Empowered Independence through Assistive Technology

Medication Management and Autonomy

The use of medication reminder devices was suggested to significantly enhance patients' ability to manage their medication independently, promoting a sense of control over their health. This theme was prominent across all focus groups, with numerous participants highlighting how medication management technologies provided autonomy and reduced reliance on caregivers. One formal caregiver highlighted:

"The medication reminder device has been a...something of a blessing. It ensures my patient takes his pills on time without me constantly reminding him. He feels more in control of his health, and I have peace of mind knowing he's managing his medication independently."

[FC3, Group B]

A participant with dementia noted the utility of an automatic pill dispenser:

"The automatic pill dispenser has been a real help. It gives me my pills right when I need them. I used to forget my doses all the time, but now I feel like I can handle my medication by myself. It makes sure I get the right pills at the right times and even gives me a little reminder to take them. I don't have to depend on others as much to manage my medication, and it makes me feel like I have more control over my health." [PwD5, Group A]

while another participant with dementia within the same focus group noted:

"It not only reminds me to take my pills, but it also keeps track of what I've taken and when... It's brought a lot of peace of mind to both me and my family." [PwD2, Group A]

The sentiment around medication management devices was predominantly positive, with participants expressing appreciation for the independence these tools provided. However, discussions also revealed concerns about potential system failures, highlighting the vulnerability created by reliance on technology for critical health tasks. As one participant with dementia noted:

"When the pill box doesn't work properly, I get confused about whether I've taken my medication or not. Sometimes I end up skipping doses because I'm not sure, and that can be dangerous." [PwD7, Group D]

While medication reminder systems generally enhanced independence and provided reassurance, their failures highlighted the vulnerability of reliance on technology for critical health tasks.

Assistance in Activities of Daily Living

Assistive technologies for daily living tasks, such as voice-activated assistants and smart home systems, offer varying degrees of effectiveness. The experiences shared by participants demonstrated a significant range in utility, with some finding these tools liberating while others encountered frustrating barriers to effective use. While one participant with dementia shared:

"Using the machine voice lady [smart home system] to turn lights on and off has made me feel more capable around the house. Before, I would struggle to remember where the light switches were, especially at night-time.... ...I just use my voice, and it's so much easier. I don't need to ask for help as often, but it does tell me that it doesn't recognise my voice often, which does make turning lights on take some time." [PwD1, Group A]

others encountered challenges with the technology's reliability and usability:

"The voice-activated assistant has been more frustrating than helpful. My husband struggles to get it to understand his commands." [IC8, Group C]

This contrast in experiences was a recurring pattern throughout the focus groups, highlighting how the same technology could either enhance or diminish independence depending on its implementation and the specific needs of the individual. As discussions progressed, participants often built upon each other's comments, revealing the multifaceted nature of technology adoption:

"I've found that some days the voice control works perfectly, and other days when my symptoms are worse, it's like the device can't understand me at all. It's not consistent enough to really rely on." [PwD4, Group B]

Technologies supporting daily routines showed mixed efficacy. The potential for AI-assisted guidance in daily activities emerged as a promising avenue, albeit one that raises ethical considerations regarding technological intervention in personal care.

Theme 2: Frustrations with Unreliable and Unpredictable Technology

Accuracy and Dependability Issues

GPS monitoring wearables and other safety devices aimed at providing peace of mind often fall short due to issues with accuracy and reliability. This theme generated some of the strongest emotional responses during the focus groups, with participants expressing significant frustration about technologies that promised safety but delivered uncertainty. One formal caregiver expressed frustration:

"The GPS monitoring wearable often sends confusing alerts about my [name removed] location... now I doubt its reliability." [FC5, Group C]

Similarly, a participant with dementia remarked:

"This watch [GPS monitoring wearable] was supposed to make me feel safer, but it often sends confusing or false alerts saying I need help or have fell over. I strongly dislike it."

[PwD6, Group D]

The discussion around this topic revealed deeper concerns about the psychological impact of unreliable safety technologies. When these devices failed or gave false alerts, they not only failed to provide their intended benefit but actually created new sources of anxiety and distress:

"Every time it sends a false alarm, my daughter panics and calls me immediately. After a while, it started causing more stress than security for both of us. We eventually stopped using it altogether." [PwD3, Group B]

These technologies offered increased autonomy but were frequently compromised by false alarms and inaccuracies, potentially exacerbating anxiety and undermining trust in the devices.

Communication Barriers with Voice Recognition

Voice-activated assistants intended to simplify tasks frequently fail to recognize commands, leading to increased frustration and dependence. This subtheme emerged consistently across all focus groups, with participants detailing specific instances where voice recognition failures created significant barriers to technology adoption. One participant with dementia mentioned:

"The voice-activated assistant was supposed to help me feel safer, but it often doesn't understand my commands. I get frustrated when I try to use it to call for help or check if the doors are locked. Instead, I doubt its reliability and have to call a family member." [PwD8, Group C]

The discussions revealed that voice recognition issues were particularly problematic for individuals with speech affected by their dementia:

"Since my speech has become slightly slurred, none of these voice systems work for me anymore. They just say 'I didn't understand that' over and over. It makes me feel like I'm the problem, not the technology." [PwD4, Group B]

"We tried three different brands of voice assistants, and none of them could consistently understand my mother's commands. Eventually, she just gave up and went back to doing things the old way, even though it's harder for her." [IC6, Group A]

Users reported significant frustration with these devices, particularly due to speech recognition difficulties. This suggests that current voice-activated technologies may inadvertently reinforce feelings of incapacity in people living with dementia.

Theme 3: Navigating the Complexity and Accessibility Challenges of Digital Interfaces

User-Friendly Design Barriers

Many participants found digital interfaces of assistive devices and applications overly complex, leading to feelings of dependence and frustration. This theme revealed a fundamental mismatch between the cognitive demands of current digital interfaces and the capabilities of people living with dementia. Participants across all focus groups shared detailed accounts of their struggles with various technologies. For instance, a participant with dementia trying to use a digital banking app shared:

"The interface was too complex, and she couldn't navigate it independently." [IC11, Group B]

Another echoed similar sentiments about an online grocery shopping platform:

"The website had too many buttons and choices, and I couldn't figure out how to finish my order." [PwD2, Group A]

The discussions revealed specific interface elements that created barriers, providing valuable insights for future design improvements:

"The tiny text is impossible for me to read, and when I try to make it bigger, the whole layout gets confusing. And why do they keep changing where things are? Just when I learn where the shopping cart button is, they move it somewhere else." [PwD5, Group A]

"My father spent nearly an hour trying to pay a bill online because the confirmation button was hidden at the bottom of the page and required scrolling. He just kept clicking everywhere else, getting more and more frustrated." [IC4, Group C]

Complexity of interfaces was a recurring barrier to technology adoption, emphasizing the critical need for user-centred design processes that actively involve people living with dementia.

Challenges in Online Social Engagement

Efforts to facilitate online social interaction among dementia patients often resulted in discomfort and fatigue. Participants' accounts revealed unexpected barriers to digital socialization, challenging common assumptions about the benefits of video-based communication for people with dementia. A formal caregiver detailed one of these experiences:

"I tried joining two of my patients together, and encouraged they join an online book club, as they are both avid readers, but, even with support they just couldn't keep up with the reading or remember the discussions from week to week, and this was a dementia group. It certainly made both feel uncomfortable. I don't think it had anything to do with the type of books or people in the group, it was just the fact both found the online nature of it all extremely fatiguing. I'm aware both do use separate support groups, that are solely audio based, which run on Mondays by a local charity, and they always mention how much easier it is without having to use their screens. I mean, it's only zoom, without cameras, but the lack of visuals seems to really help them." [FC2, Group B]

The focus groups revealed a strong preference for in-person social interactions, with participants across all groups expressing similar sentiments:

"There's something about being in the same room with someone that no technology can replace. I can follow conversations better when I can see people's real expressions and feel their presence." [PwD7, Group D]

Experiences varied widely, with an unexpected preference for audio-only platforms over video calls in some cases, challenging assumptions about optimal communication modalities for this population. Likewise, in-person experiences were pushed heavily by several participants with dementia:

"completely online interaction just won't work, I want to see people in person, having someone on a screen just adds to my confusion" [PwD1, Group A]

to which numerous participants with dementia and caregivers said "I agree" or "I'd like that too" in approval. One individual added:

"I'd love an app that shows me communities in my local area, or a list of local activities to things I haven't done before, an app to push you out the house my saying 'look at this fun event that is running, please come', especially for us that don't have family, friends, or caregivers, we need that sense of social connection" [PwD3, Group B]

Theme 4: Desired Innovations in Adaptive and Responsive Technologies

Health and Mood Monitoring Technologies

Participants expressed a strong desire for technologies that can monitor and adapt to their health and emotional states. This theme reflected a forward-looking perspective, with participants envisioning technology solutions that could address unmet needs in dementia care. One formal caregiver suggested:

"It would be helpful to have a device that can monitor patients' moods and alert myself and other caregivers if the patient is feeling particularly anxious or confused. Sometimes my patients can't express how they are feeling, and having something that tracks feelings may help provide better support for those I care for". [FC1, Group A]

This was closely mirrored by a participant with dementia:

"...I wonder if a device exists that I can wear that can track my mood and tiredness, and help with things like that... or maybe just tell my carer that I could do with their help." [PwD6, Group D]

This was closely followed by agreement with a medical practitioner:

"a device, perhaps something associated with variability of cardiac rhythm would be a fantastic one. Certainly, knowing more objective information about our patients, whether that be mood, fatigue, or something more pathological, for the benefit of both the care giver and clinician working with the individual could only be an advantage." [ME1, Group C]

The focus group discussions revealed nuanced perspectives on mood monitoring, with some participants expressing enthusiasm while others raised concerns about privacy:

"I'd appreciate something that could tell when I'm getting anxious before I even realize it myself. Sometimes my anxiety builds up slowly and I don't notice until I'm already overwhelmed." [PwD8, Group C]

"I worry about being constantly monitored though. Would I always feel like I'm being watched? Would my family start treating me differently based on what the device tells them about my mood?" [PwD5, Group A]

Interest in mood monitoring technologies was evident, but raised important questions about privacy and the potential over-medicalization of emotional states.

User-Responsive and Adaptive Technologies

There was a call for more intuitive and adaptive technologies. This subtheme emerged across all focus groups, with participants articulating specific ways in which technology could better accommodate the changing nature of dementia symptoms. One participant with dementia wished for a device that could adapt to their needs:

"I want all apps to have a feature that can adjust to my changing needs throughout the day or as my condition progresses." [PwD2, Group A]

Another participant with dementia mentioned the potential benefits of a simpler GPS device:

"I wish there was a simpler, more user-friendly GPS device specifically designed for people like me. It could have bigger buttons and clearer instructions, and maybe even a feature that alerts my family if I make a wrong turn." [PwD7, Group D]

In the context of driving, another individual with dementia notes:

"It would be great to have a dashboard display that not only shows directions but also reminders for my destinations. Sometimes I forget where I'm going or why, and a little reminder on the screen would help me stay focused." [PwD4, Group B]

The discussions around adaptive technologies revealed a desire for systems that could provide personalized support without being intrusive or stigmatizing:

"I want technology that works with me as I am, not technology that makes me feel like I'm being treated like a child or a patient. Something that gives me just enough help when I need it, but lets me do things myself when I can." [PwD1, Group A]

"The ideal would be something that learns my patterns and knows when I'm having a good day versus a difficult day, and adjusts accordingly without me having to tell it." [PwD6, Group D]

The data revealed a significant demand for adaptable interfaces capable of responding to the fluctuating cognitive capacities characteristic of dementia progression.

Theme 5: The Dual-Edged Impact of Specific Assistive Technologies

Smart Home Systems and Security Concerns

Certain smart home systems were reported to enhance safety and ease of living significantly. This theme highlighted how the same category of technology could yield dramatically different outcomes depending on specific features and implementation. An informal caregiver noted:

"The home security system that installed helps my dad feel much safer at night. It's easy to use, and the automatic door locks make sure the house is secure. I don't have to worry about whether he remembered to lock up before bed because it does it for me, or I can do it from my phone." [IC9, Group D]

albeit an alternative opinion was presented by a different participant with dementia related to smart doorbells:

"Unlike the smart home system that locks the house, the smart doorbell is too confusing for my dad. Sometimes he missed important visitors because he can't figure out how to use it. It makes him feel more vulnerable, not safer, because he can't always see who's there before opening the door." [IC7, Group B]

The discussions revealed detailed insights about which smart home features were most beneficial and which created challenges:

"The automatic lighting that turns on when I enter a room has been absolutely fantastic. I never have to worry about finding switches in the dark or remembering to turn lights off when I leave a room." [PwD3, Group B]

"The smart thermostat, though, is impossible. There are too many settings and options, and I can never remember how to make simple adjustments. We ended up putting tape over it and just using the old manual controls." [PwD5, Group A]

Experiences ranged from highly beneficial (e.g., automatic lighting) to problematic (e.g., complex security systems), underscoring the importance of personalized technological solutions.

Emergency Response Limitations

Emergency response devices, such as neck-worn call buttons, were highlighted for their effectiveness in providing a sense of security. This subtheme elicited some of the most emotional responses during the focus groups, with participants expressing both gratitude for the security these devices provided and frustration with their limitations. One participant with dementia shared:

"Having the emergency call button on my neck makes me feel secure. If I ever need help, I can get it with just one press. It's reassuring to know that I can reach someone quickly if something goes wrong. This gives me the confidence to do things on my own, like go for a small walk with the dog." [PwD8, Group C]

Again, an alternative stance was noted with respect to security-based applications:

"I tried using a security type app on my phone to stay safe, but it's too complicated for me or my husband [referring to a person with dementia] to use properly. I often forget how to use it, and instead of making us feel secure, it just adds to our anxiety, and I'm a tech savvy person for my age, so it's not my fault. I end up worrying more about not being able to use it in an emergency. Instead, I just rely on my husband's careline necklace, but the problem with that is that he can't take it into the bath, or he forgets to wear it, or I loses it often. They are so small, you know." [IC3, Group C]

The discussions revealed specific design limitations that affected the utility of these devices in real-world settings:

"The call button is useful, but only if you're wearing it. My mother often takes it off when she showers and forgets to put it back on. We need something waterproof that she could wear all the time." [IC10, Group B]

"The button itself is good, but it's attached to this cord that gets tangled in everything. My father got his caught on a door handle once and it nearly choked him. It needs a better design." [IC5, Group A]

While these provided significant reassurance, physical limitations in their use highlighted the need for more comprehensive, context-aware design in assistive technologies.

Frequency Analysis

The frequency analysis of highlighted quotes demonstrated several prominent themes related to the use of assistive technologies among participants with dementia and their caregivers. Medication management emerged as a significant theme, with eight mentions (20%) across various quotes. Key terms such as "medication reminder device," "automatic pill dispenser," "digital pill system," and "smart pill bottle" were frequently referenced, underscoring the critical role these technologies play in supporting medication adherence and independence. This frequency of mentions highlights the perceived value of these technologies, aligning with the positive sentiment (32.5%) attributed to their impact. However, it is important to note that their reliability concerns contributed to the 35% of negative sentiments, reinforcing the need for improved system dependability. Assistive technology for daily living was mentioned nine times (22.5%), with devices like voice-activated assistants and smart home systems being notable examples. While these technologies were largely appreciated, sentiment analysis revealed frustration (35%) surrounding their usability and complexity, highlighting the need for more intuitive interfaces.

GPS and safety devices also appeared prominently, with seven mentions (17.5%), reflecting their intended purpose of ensuring patient safety and providing peace of mind for caregivers. Complexity and usability issues were the most frequently mentioned concerns, with ten references (25%). These findings correlate with the sentiment analysis, which identified complexity as a major source of frustration. Terms such as "too complex," "confusing," "frustrating," and "overwhelming" highlighted the challenges faced by participants with dementia and caregivers in navigating these technologies. Online social interaction and digital interfaces, while less frequently mentioned (four times, 10%), were identified as areas causing discomfort and fatigue among users. Finally, mood and health monitoring technologies were discussed five times (12.5%), indicating a desire for tools that can provide more comprehensive and adaptive support. Emergency and security concerns were also significant, with five mentions (12.5%), emphasizing the need for reliable and user-friendly

emergency response systems. Finally, adaptive and user-friendly technologies were mentioned seven times (17.5%), reflecting a strong demand for more intuitive and accessible solutions tailored to the needs of dementia patients.

Sentiment Analysis

The sentiment analysis of highlighted quotes demonstrated a balanced mix of positive, negative, and neutral sentiments across the quotes. Positive sentiments were expressed in 13 quotes (32.5%), particularly regarding medication management and certain assistive devices. For example, the medication reminder device and automatic pill dispenser were described as blessings that promote independence and peace of mind. This aligns with the frequency analysis, which found medication management technologies to be one of the most frequently mentioned categories (20%), reinforcing their perceived value. Similarly, technologies like voice-activated assistants and smart home systems were appreciated for enhancing daily living capabilities, despite some usability challenges. Negative sentiments were found in 14 quotes (35%), primarily associated with the complexity and reliability issues of various technologies. This is reflected in the frequency analysis, where usability concerns were the most frequently mentioned issue (25%), suggesting that despite their potential benefits, these technologies often introduce frustration and additional burdens. Participants frequently expressed frustration with voice-activated assistants, security apps, and GPS monitoring wearables, citing their inability to simplify tasks as expected. The complexity of digital interfaces for online grocery shopping and digital banking apps also contributed to negative experiences, leading to feelings of dependence and frustration among users. Neutral sentiments, present in eight quotes (20%), generally involved observations and suggestions for improving existing technologies. These neutral responses highlight an awareness of the potential benefits of assistive technology but also emphasize the need for improvements, particularly in accessibility and adaptability.

Discussion

The findings from our analysis underscore the dual-edged nature of assistive technologies for dementia care. The thematic analysis appeared to demonstrate that while innovations such as medication management devices and daily living assistance tools are praised for enhancing independence and providing peace of mind, significant challenges persist. Caregivers, medical practitioners, and participants with dementia frequently cited issues with the complexity and reliability of these technologies, leading to frustration and reduced confidence in their use. Additionally, while assistive technologies like GPS monitoring and home security systems promote safety, their usability issues often cause anxiety and reliance on caregivers. Online social interactions and digital interfaces were found to be

particularly taxing for dementia patients, indicating a need for more streamlined, less visually intensive solutions. The frequency analysis showed that medication management was mentioned in 20% of the quotes, assistive technology for daily living in 22.5%, and usability issues in 25%. GPS and safety devices appeared in 17.5%, and mood and health monitoring in 12.5%. These numbers correlate with the sentiment analysis, where 32.5% of quotes expressed positive sentiments, 35% were negative, and 20% were neutral. This mixed sentiment landscape suggests that while assistive technologies provide tangible benefits, their usability issues significantly impact user satisfaction. The insights gleaned from this study highlight the necessity for the development of more user-friendly, adaptive, and reliable assistive technologies. Addressing these issues is crucial to maximizing the potential benefits of these tools and improving the overall quality of life for both dementia patients and their caregivers in the context of independence. Below we will discuss our observations for each sub-theme.

Technologies, such as medication reminder systems, emerged as a significant tool in promoting independence and adherence among people living with dementia. These technologies generally enhanced autonomy and provided reassurance to both patients and caregivers (see Pillai & Bonner-Jackson, 2015 for review). However, the data revealed vulnerabilities associated with technological reliance, particularly when systems failed. Particularly, negative sentiment, accounting for 35% of responses, frequently arose due to concerns about reliability and usability issues. This aligns with findings by Thordardottir et al. (2019), who noted the potential for increased anxiety when assistive technologies malfunction. Our findings also revealed a consistent pattern of reliance on caregivers for interpreting and managing technology data, particularly for health monitoring and medication management systems. Participants with dementia frequently reported needing assistance to understand alerts, interpret health metrics, and respond appropriately to system notifications. This dependency created an additional burden for caregivers, who often became *de facto* technology managers and data interpreters (Berridge & Wetle, 2020). The data suggests that while current technologies aim to promote independence, they may inadvertently create new forms of dependency when the information they provide is not accessible or comprehensible to the person with dementia (Rosenberg & Nygård, 2017). The balance between empowerment and dependence highlighted by these systems reflects broader debates in gerontechnology about the role of technology in supporting aging in place (Peek et al., 2016). Future developments in this area should focus on improving reliability and incorporating fail-safe mechanisms to mitigate risks associated with system failures. Likewise, technologies supporting daily routines showed mixed efficacy, echoing findings by Lorenz et al. (2019) on the varied impacts of assistive technologies in dementia care. The potential for AI-assisted

guidance in daily activities emerged as a promising avenue, aligning with recent advancements in ambient assisted living systems (Rashidi & Mihailidis, 2013). However, this potential is tempered by ethical considerations regarding privacy and autonomy (see Ienca et al., 2018 for review). The data suggests a need for personalized, adaptive systems that can provide tailored support while respecting individual preferences and capabilities. This aligns with the concept of "person-centered technology" proposed by Astell et al. (2019), emphasizing the importance of matching technological interventions to individual needs and values in dementia care.

GPS and safety devices also offered increased autonomy but were frequently compromised by false alarms and inaccuracies. These devices were mentioned in 17.5% of analysed quotes, indicating their prominence in discussions about assistive technology. This finding aligns with research by Olsson et al. (2019), who identified reliability as a key factor in the acceptance of tracking technologies among older adults. The potential for these devices to exacerbate anxiety and undermine trust reflects broader concerns about the psychological impacts of surveillance technologies in dementia care (Malmgren et al., 2020). Despite these challenges, the data suggests that when functioning correctly, these devices can significantly enhance feelings of safety and independence (see Teipel et al., 2018 for discussion), supporting findings by Teipel et al. (2018) on the benefits of location-based services for people with dementia. In line with assistant technology devices, participants, mainly participants with dementia, reported significant frustration with voice-activated assistants, particularly due to speech recognition difficulties. In fact, prior literature has identified speech recognition as a major barrier to the adoption of voice assistants among older adults (Pradhan et al., 2018). The data suggests that current voice-activated technologies may inadvertently reinforce feelings of incapacity in people living with dementia (see Vacher et al., 2015 for discussion). Despite these challenges, the potential benefits of voice-activated systems in supporting independence and reducing cognitive load remain significant (Portet et al., 2013). While considering the ethical implications of continuous monitoring, future developments must both increase accuracy and reliability of these systems while, in the context of voice assistants, improve speed recognition algorithms to better accommodate varied speech patterns.

The complexity of digital interfaces, as noted previously (Czaja et al., 2019), emerged as a recurring barrier to technology adoption among people living with dementia. The data emphasizes the critical need for user-centred design processes that actively involve people living with dementia (i.e., co-design approaches; Astell et al., 2019). Participants expressed a desire for simpler, more intuitive interfaces, reflecting the principles of inclusive design (see Newell et al., 2011 for discussion). The struggle with complex interfaces highlights the importance of considering cognitive load and attention limitations in interface design for people

living with dementia (e.g., Gerling et al., 2020). Likewise, experiences with online social interaction platforms varied widely, with, to the authors surprise, an unexpected preference for audio-only platforms over video calls in some cases. This finding challenges assumptions about optimal communication modalities for people living with dementia (e.g., Moyle et al., 2020). The data suggests that the cognitive demands of video-based communication may be overwhelming for some people living with dementia, perhaps supporting simpler communication technologies (e.g., Lindauer et al., 2017). This preference for audio-only communication may also reflect generational familiarity with telephone conversations among older adults, who have decades of experience with audio-only communication compared to relatively recent exposure to video calls (Neves et al., 2019). For many participants with dementia, the cognitive effort required to process visual cues in video calls may outweigh the benefits, particularly when the audio channel already provides sufficient social connection (Yuan et al., 2021). The preference for audio-only communication in some cases highlights the need for flexible, multimodal communication options that can be tailored to individual cognitive abilities and preferences, relating back to the prior mention of person-centred approaches.

The strong preference for face-to-face interactions over online communication was repeatedly noted when discussions related to online platforms, like research demonstrating videoconferencing may not replace the value of in-person contact for all populations (e.g., those with cognitive impairments; Moyle et al., 2020). The comment about the need for social connection, especially for those without family or caregivers, highlights the critical issue of social isolation among older adults with dementia (e.g., loneliness; Victor et al., 2020). This preference underscores the need to consider technology as a complement to, rather than a replacement for, human interaction in dementia care (Astell et al., 2019). The suggestion for an application that promotes local activities and community engagement reflects the potential for technology to serve as a bridge to real-world social interactions. This aligns with the concept of technology could be used to connect individuals with community resources and activities (i.e., "social prescribing"; see Chatterjee et al., 2018 for detailed review). The desire for personalized activity suggestions based on individual interests and new experiences reflects the principles of person-centered care in dementia, as noted previously (Kitwood and Bredin, 1992). This suggests a potential role for AI and machine learning in tailoring social engagement recommendations to individual preferences and capabilities.

Experiences with smart home systems ranged from highly beneficial (e.g., automatic lighting) to problematic (e.g., complex security systems), underscoring the importance of personalized technological solutions, aligning with prior literature (Liu et al., 2019). The data appeared to demonstrate that while some smart home features can enhance safety and

independence (e.g., Rantz et al., 2013), others may introduce new challenges or sources of frustration (see Mortenson et al. 2016 for discussion associated with the potential debilitating nature of assistive technologies). However, the difficulties reported with more complex systems highlight the need for careful consideration of cognitive accessibility in smart home design (e.g., Carnemolla and Bridge, 2020). In line with security, emergency response devices were suggested to provide reassurance to users and caregivers, as noted prior (Stokke, 2016). However, the data also revealed physical limitations in their use, such as the inability to wear devices in the bath, highlighting the need for more comprehensive, context-aware design in assistive technologies. Discussions clearly demonstrated the benefit of devices in terms of perceived safety (Peek et al., 2014) and concerns of potential vulnerabilities created by such systems (Berridge, 2017). Perhaps development in this area should focus on creating more versatile, waterproof devices and exploring alternative form factors that can provide continuous protection without compromising comfort or dignity (see Kolodziej et al., 2017 for discussion on wearable fall systems).

Finally, consistent with prior literature (Gerling et al., 2020), several participants with dementia noted a significant demand for adaptable interfaces capable of responding to the fluctuating cognitive capacities characteristic of dementia progression. Participants expressed a desire for systems that could simplify or automate tasks based on their current cognitive state, reflecting principles of context-aware computing (Rashidi & Mihailidis, 2013) and personalised tools (Gibson et al., 2016). Sentiment analysis revealed a mix of positive and neutral responses to adaptive technology, indicating recognition of its potential but also a degree of scepticism regarding its current effectiveness. Future developments in this area should focus on creating intelligent systems that can assess user capabilities in real-time and adjust interface complexity, accordingly (see Astell et al., 2019 for discussion on next-generation dementia care technologies).

Study Implications

The mixed effectiveness of technologies highlighted in this study has important implications for future developments in this field. Technology developers and researchers must recognize that one-size-fits-all solutions are unlikely to meet the diverse and evolving needs of people living with dementia. Instead, a more personalized, adaptive approach to assistive technology design is crucial. By incorporating user feedback and continuously evaluating the real-world performance of these tools, developers can create more reliable, user-friendly, and effective solutions. This will require close collaboration with people living with dementia, caregivers, and healthcare professionals to ensure that new innovations address the specific challenges faced by this population. For caregivers, these findings

underscore the need for comprehensive training and support in the use of assistive technologies. Caregivers play a vital role in facilitating the adoption and effective use of these tools and empowering them with the knowledge and skills to troubleshoot issues can enhance the likelihood of successful integration into daily routines. Policymakers and healthcare organizations should prioritize the development of caregiver-focused resources and educational programs to address this gap. Furthermore, the insights gained from this study can guide future innovations in dementia care technologies. Technology developers should prioritize simplicity, adaptability, and robust fail-safe mechanisms to enhance the usability and reliability of their products. Designing interfaces that accommodate cognitive impairments and minimizing the cognitive load required for operation are also key considerations. Ongoing user testing and iterative design processes will be critical to ensuring that new technologies meet the evolving needs of people living with dementia. For policymakers, these findings highlight the need for comprehensive, coordinated strategies to support the integration of assistive technologies into dementia care pathways. This may involve developing funding mechanisms, regulatory frameworks, and infrastructure to facilitate the widespread adoption and accessibility of these tools. Collaboration between technology developers, healthcare providers, and policymakers will be essential to ensuring that innovative solutions are effectively implemented and accessible to those who need them most.

Usability and Error Tolerance in Assistive Technologies

In relation to core usability literature (e.g., Nielsen, 1994), the critical importance of usability in assistive technologies for people living with dementia, particularly in terms of error tolerance, is clearly highlighted by our findings. For example, error tolerance, is crucial in dementia care technologies due to increased likelihood of user errors stemming from cognitive impairments, and our findings demonstrate individuals with cognitive impairments are more susceptible to errors and discouragement from system failures (Czaja et al., 2019). This underscores the need for easy-to-use and error-forgiving assistive technologies (Keates & Clarkson, 2003). Likewise, participants' preference for simpler, intuitive interfaces (e.g., "minimalist design"; Carroll, 1990), advocates for reduced complexity and cognitive load (Keates & Langdon, 2002; Keates et al., 2009). Challenges with voice-activated assistants highlight the importance of multimodal interaction in error-tolerant design (e.g., Pradhan et al., 2018). The desire for adaptable interfaces reflects Nielsen's (1994) "flexibility and efficiency of use" principle and appears consistent with more recent literature (see Martínez-Alcalá et al., 2016 for discussion). Our findings underscore the significance of system status visibility and recognition-based interfaces in smart home and emergency response systems for dementia care (Nielsen, 1994). Clear feedback and intuitive controls reduce errors and enhance user autonomy. Given the potential consequences of errors in these technologies,

prioritizing error-tolerant design is crucial to support people living with dementia effectively while minimizing safety risks and preserving independence (Ienca et al., 2018).

Limitations and Future Directions

The sample size of 35 participants, though modest, allowed for in-depth exploration of experiences and perspectives (Guest et al., 2017). The diversity of the sample, including people living with dementia, informal and formal caregivers, and medical professionals, provided a holistic view of the topic from multiple stakeholder perspectives. However, while diverse, this may not be fully representative of the broader population affected by dementia, a common limitation in qualitative research influencing the generalizability (Creswell & Poth, 2018). Additionally, our inclusion criteria requiring all participants to have capacity to consent may have limited representation of individuals with more advanced dementia, potentially excluding insights from those who experience the most significant cognitive challenges when using assistive technologies. This limitation is notable as these individuals might benefit most from well-designed assistive technologies but face the greatest barriers to their use (Ienca et al., 2017). The use of convenience and snowball sampling techniques, while practical, may have introduced selection bias, potentially overrepresenting certain perspectives or experiences (Etikan et al., 2016). However, these methods are effective for reaching specialized populations, particularly in dementia research where recruitment can be challenging (Kirchherr & Charles, 2018). The study's inclusion of solely English-speaking participants could have excluded valuable insights from non-English speaking people living with dementia or caregivers, limiting the cultural diversity of the findings (Morales & Ladhari, 2011).

The variation in group sizes, ranging from 4 to 11 participants, potentially effected the consistency of data across groups, yet aligns with recommended focus group sizes in qualitative research, allowing for both intimate discussions and broader group dynamics (Krueger & Casey, 2015). The 45-minute duration might have also limited the exploration of complex topics related to assistive technologies and dementia care; however, it was deemed appropriate for participants with cognitive impairments, balancing depth of discussion with participant comfort and attention spans (Murphy et al., 2015). In line with the above, future research should aim to expand the sample size and diversity, potentially incorporating a mixed-methods approach that combines qualitative insights with quantitative data on technology usage and outcomes. Longitudinal studies that track the long-term experiences of people living with dementia and their caregivers as they adopt and use assistive technologies could provide valuable insights into the evolving needs and challenges over time. Additionally,

cross-cultural comparisons could shed light on how cultural and societal factors influence the acceptance and use of these technologies.

While frequency analysis provides a valuable quantitative measure of key themes, it does not capture the depth of user experiences or contextual nuances. The sentiment analysis helps to bridge this gap by illustrating the emotional impact of these themes, yet it remains limited in its ability to explain underlying reasons for these sentiments. For instance, while frequency analysis revealed high mentions of usability issues (25%), sentiment analysis demonstrated that these challenges elicited frustration (35% negative sentiment). However, without qualitative context, the specific pain points or barriers within usability remain unclear. Additionally, sentiment analysis may oversimplify emotions by categorizing them as positive, negative, or neutral, when user experiences are often complex and multi-layered. A combined approach, integrating these methods with qualitative feedback, is necessary to fully understand how assistive technologies shape the lived experiences of dementia patients and caregivers.

Call to Action for Stakeholders

The findings of this study underscore the urgent need for collaboration among all stakeholders in the dementia care ecosystem. Technology developers must actively engage with people living with dementia, caregivers, and healthcare providers to ensure that new innovations are designed with the user's needs and preferences at the forefront. Caregivers and healthcare professionals should be empowered with the knowledge and resources to effectively integrate assistive technologies into their care practices, while policymakers must prioritize the development of supportive infrastructure and funding mechanisms to facilitate the widespread adoption of these tools. Only through such concerted efforts can we ensure that the promising potential of assistive technologies is fully realized, enhancing the independence, safety, and quality of life for people living with dementia. We call on all stakeholders to heed the insights gained from this study and commit to working together to drive meaningful progress in this critical area of dementia care.

Conclusion

This study highlights the complex interplay between assistive technologies and the lived experiences of people living with dementia. While these technologies offer significant potential for enhancing independence and safety, they also present challenges in terms of usability, reliability, and potential negative psychological impacts. The findings underscore the critical need for user-centred design approaches that actively involve people living with dementia in the development process. Future innovations should focus on creating more

intuitive, adaptable interfaces that can accommodate the fluctuating cognitive capacities characteristic of dementia progression. Additionally, there is a clear need for technologies that complement rather than replace human interaction, addressing the risk of social isolation. The preference for simpler, more reliable systems over complex solutions emphasizes the importance of balancing technological advancement with practical usability. By addressing these challenges and leveraging the insights gained from this study, future assistive technologies can hopefully become more effective in supporting independence and improve quality of life for people living with dementia and their caregivers.

Author notes

The facilitator and other researchers present were surprised by a recurring theme that emerged consistently before and after the focus group sessions. Although separate from the primary topic of discussion, participants across all groups frequently expressed concerns about the post-diagnostic experience. These concerns centred around four key issues: a lack of comprehensive information provided following their dementia diagnosis; insufficient support offered or made available after diagnosis; a scarcity of accessible and understandable information about dementia; and limited or no information about local dementia communities or resources tailored to support their individual circumstances. This unexpected but consistent feedback highlighted a significant gap in post-diagnostic care and support services for people living with dementia and their caregivers, despite this not being the intended focus of the study. This finding demonstrates a critical gap in post-diagnostic care and support services for people living with dementia and their caregivers, consistent with prior literature (Górska et al., 2013; Morrisby et al., 2018). The consistency of this theme across all focus groups, despite not being a direct focus of the study, underscores its significance and urgency. The recurrence of this topic suggests that despite ongoing efforts to improve dementia care pathways, there remains a substantial disconnect between diagnosis and the provision of practical, actionable support. The apparent lack of awareness about local dementia communities and support networks is particularly concerning, as social support and community engagement have been shown to significantly impact quality of life for people living with dementia (Han et al., 2016). This gap in knowledge transfer could potentially be addressed through the development of targeted technological solutions, such as user-friendly apps or websites that consolidate local resources and support services (see Lorenz et al., 2019 for further discussion). Furthermore, this finding points to a potential area for future research, focusing on the development and evaluation of comprehensive, accessible information packages and support systems for newly diagnosed individuals and their caregivers. It also highlights the need for better integration of assistive technologies within broader support frameworks.

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