Telepresence Robots as Emerging Technologies in Elderly Care and Wellbeing: The Case of Estonia

Sirje Virkus, Marianne Paimre
School of Digital Technology
Tallinn University
Narva mnt 25, 10120 Tallinn, Estonia
sirje.virkus@tlu.ee, marianne.paimre@tlu.ee

***Abstract**. This study investigates the role of telepresence robots (TPRs) in supporting older adults through a mixed-methods approach combining a systematic literature review and 54 semi-structured interviews with caregivers, medical professionals, and older adults in Estonia. Findings highlight TPRs' potential to reduce loneliness, improve access to care, and enhance autonomy. A persona-driven analysis reveals diverse needs and attitudes among caregivers, medical professionals, and elderly individuals. Key challenges include ethical concerns, technological unfamiliarity, and infrastructural constraints. The study offers actionable design and policy recommendations to support user-centered TPR integration in eldercare, emphasizing inclusivity, trust-building, and contextual adaptability to ensure successful deployment.*

Keywords. telepresence robots, elderly care, caregivers, medical professionals, older adults, literature review, qualitative research, personas, Estonia

1 Introduction

Telepresence robots (TPRs) are remotely operated mobile devices equipped with video, audio, and navigational capabilities. Typically integrating cameras, microphones, speakers, and display screens, these robots enable users to experience a sense of physical presence in remote environments. As a form of technological mediation, TPRs facilitate real-time interaction across geographical distances, offering new possibilities for communication and engagement (Virkus, 2025).

The pioneering work by Paulos and Canny (1998) marked the first systematic exploration of mobile robotic telepresence. Their research was primarily motivated by a desire to understand the social and psychological dimensions of sustained human-to-human interaction through technological mediation. Since then, TPRs have attracted interests across various sectors, including healthcare, education, industry, museums, and corporate environments (Virkus et al., 2023).

One particularly promising domain for TPRs is elder care. The aging of populations presents substantial challenges to healthcare and welfare systems globally (EC, 2021; WHO, 2015). At the same time, the expansion of digitalization has created opportunities for promoting independent and healthy aging (Nimrod, 2020). In many high-income countries, digital health applications now empower older adults to monitor their well-being and manage minor medical issues autonomously (Arthanat, 2021; Chu et al., 2021). However, despite the growing availability of smart technologies, a considerable portion of the elderly population remains either reluctant or unable to use them effectively (Paimre et al., 2023).

Estonia, a recognized leader in digital transformation, exemplifies the potential and limitations of this shift. It has achieved notable progress in e-government and e-health, consistently ranking among the top EU countries in digital public services (European Commission, 2022; Ojaperv & Virkus, 2023). However, Estonia's social welfare provision, especially for vulnerable groups like older adults, still trails behind that of more developed Western nations (Leppiman et al., 2021; Paimre et al., 2023, 2024).

This paper investigates the role of TPRs in providing support and companionship for the elderly, with a specific focus on the Estonian context. Combining a systematic literature review with qualitative interviews of caregivers, medical professionals, and elderly individuals, the study identifies key research gaps and stakeholder perspectives. Thematic analysis of the interviews informed the creation of user personas, offering nuanced insights into needs, preferences, and barriers. Together, these methods provide a foundation for adapting and implementing TPRs to enhance the quality of life and care for Estonia's aging population.

The structure of this paper is as follows: Section 2 outlines the research methodology. Section 3 presents the findings of the literature review. Section 4 provides an account of the personas derived from interviews with caregivers, medical professionals, and elderly individuals. Section 5 offers a discussion and concluding remarks.

2 Methodology

This study employed a mixed-methods approach that combined a systematic literature review with a persona-driven approach grounded in qualitative interviews. The research design was structured in two sequential phases to ensure both breadth of understanding from existing literature and depth of insight from real-world experiences. Phase one focused on synthesizing current academic knowledge, while phase two aimed to explore the perspectives of key stakeholders through semi-structured interviews and develop user personas grounded in the data.

The literature review was conducted in February 2024 following the PRISMA *(Preferred Reporting Items for Systematic Reviews and Meta-Analyses*) framework (Moher et al., 2009), a widely recognized standard for enhancing transparency, completeness, and replicability in systematic reviews.

Searches were performed in the Web of Science and Scopus databases using the terms “telepresence robot*” AND (“elderly” OR “older adults”). In Web of Science, queries were conducted by topic, while in Scopus, they covered the title, abstract, and keywords fields. The search yielded 25 results from Web of Science and 114 from Scopus. After deduplication and screening for relevance, 81 articles were selected for in-depth analysis. These studies were examined using thematic analysis, enabling the identification of recurring themes, knowledge gaps, and divergent findings within the literature. This phase provided an overview of current research and informed the design of the interview protocol for the second phase.

To explore user experiences and expectations regarding TPRs, a qualitative research design using semi-structured interviews was adopted. This approach allowed for flexibility in probing participant perspectives while maintaining consistency across interviews. The interviews sought to capture rich, first-person insights from key stakeholders involved in elderly care.

A total of 54 participants were interviewed, drawn from three target groups: caregivers (n=15), medical professionals (n=15), and elderly individuals (n=24). A convenience sampling method was employed to recruit caregivers and medical professionals. Elderly individuals were selected based on inclusion criteria that required the individuals to be aged 65 or older, with varying degrees of technological familiarity, to ensure a broad range of viewpoints. The caregivers ranged in age from 40 to 70 years, the medical professionals from 25 to 82 years, and the elderly participants from 65 to 86 years. To enhance understanding among participants unfamiliar with robotics, a brief video demonstration of a TPR was shown prior to the interviews. Each interview was conducted face-to-face, lasted approximately 60 minutes, and adhered strictly to ethical protocols, including informed consent, confidentiality, and participants autonomy.

The interview protocol was structured around ten thematic areas:

1. General understanding and prior experience.
2. Needs and challenges in maintaining social connections.
3. Desired features and functionalities.
4. Comfort and trust in using the technology.
5. Social and emotional impact.
6. Levels of support and autonomy.
7. Preferences for appearance and customization.
8. Safety and privacy concerns.
9. Technical support and training needs.
10. Future use and adoption potential.

Interview data were transcribed verbatim and analyzed through inductive thematic analysis. Coding occurred in multiple iterative phases, enabling the identification of patterns and the emergence of overarching themes. This thematic structure formed the analytical basis for interpreting the interviews in light of the study’s research objectives.

Drawing on the insights from the interviews, a set of user personas was systematically developed to represent archetypal stakeholders in the TPR ecosystem. Personas were developed through a systematic analysis of interview data using thematic coding and clustering techniques. These personas encapsulate the diverse motivations, behaviors, needs, and barriers associated with TPR adoption and usage. Each persona reflects a unique cluster of user characteristics and provides a conceptual model to: 1) Illustrate variation within and across stakeholder groups. 2) Inform the user-centered design of TPRs. 3) Guide implementation strategies and policy development in elderly care contexts.

Grounding the design of telepresence technologies in the experiences of end-users, these personas serve as a practical framework for creating inclusive, responsive, and adaptable robotic solutions that align with the real-world needs of older adults and their care networks.

3 Literature review

The systematic literature review was guided by the five research questions (RQs), which structured the data collection, analysis, and interpretation processes:

RQ1: What are the main topics addressed in publications concerning TPRs in elderly care?

The literature encompasses a broad range of themes related to the development, design, and implementation of TPRs, with particular emphasis on their potential to enhance social connectedness, well-being, and independent living among older adults (Moyle et al., 2014). A significant body of work investigates the perspectives of key stakeholders, including individuals living with dementia, caregivers, and healthcare professionals, to better understand the needs and concerns surrounding TPR adoption in care contexts (Shin et al., 2022). In addition, researchers examine the technological attributes of TPRs, such as mobility, interface usability, and communication capabilities, and how these influence user experience and acceptance (Ragno et al., 2023). Evaluative studies of specific TPR models highlight both the practical applications and limitations of existing technologies in real-world settings (Casiddu et al., 2015). Furthermore, investigations into psychophysiological responses provide insights into how older adults emotionally and cognitively engage with TPRs during interaction (Tiberio et al., 2012), contributing to a deeper understanding of human-robot dynamics in aging populations.

Research during the COVID-19 pandemic highlights the utility of TPRs in supporting remote exercise and care (Addas, 2023), particularly in long-term care settings (Cesta et al., 2016), emphasizing the importance of staff training, family connections, and implementation strategies (Moyle et al., 2020). Other studies explore the educational potential of TPRs for older adults (Hiyama et al., 2017).

Attitudes toward TPRs are generally positive across user groups, including older adults, caregivers, and healthcare providers (Cesta et al., 2016; Shin et al., 2022). Perceived benefits include improved communication, emotional well-being, and independent living (Koceski & Koceska, 2016; Cesta et al., 2012; Reis et al., 2018), although concerns remain about their limitations in providing physical and emotional care (Cesta et al., 2013).

Challenges identified include privacy, security, ethical concerns, technical complexity, and resistance to change (Cesta et al., 2012; Fischedick et al., 2023; Niemelä et al., 2021). Cultural differences also influence acceptance, underlining the need for broader, cross-cultural studies (Gonzalez-Jimenez et al., 2013; Zhang & Hansen, 2022). Usability, trustworthiness, and reliability are critical factors influencing adoption (Aaltonen et al., 2017; Smith et al., 2021), alongside regulatory, licensing, and liability issues (Fiorini et al., 2022).

Positive user experiences are closely linked to trust, ease of use, and prior exposure to the technology (Michaud et al., 2007). In addition to facilitating social interaction, TPRs may serve in roles such as remote health monitoring, telemedicine, cleaning, and disinfection, potentially enhancing care quality and infection control (Fiorini et al., 2022). However, successful integration requires addressing technical, ethical, and user-centered challenges (Niemelä et al., 2021).

RQ2: What are the primary applications of TPRs in elderly care, and how effective are these applications in enhancing older adults' overall well-being?

Research consistently underscores the potential of TPRs to enhance older adults' well-being by fostering social connectedness, enabling remote care, and promoting autonomy. While outcomes vary due to contextual and methodological differences, several key applications and benefits emerge:

1) *Remote monitoring and assistance:* TPRs allow caregivers and healthcare professionals to monitor older adults remotely, provide timely interventions, and enhance safety - facilitating early detection of health issues and reducing caregiver burden (Beraldo et al., 2018; Fiorini et al., 2022; Zhang et al., 2018).
2) *Social connectedness*: TPRs support virtual interactions with family, caregivers, and healthcare providers, helping to alleviate loneliness and enhance social engagement (Addas, 2023; Moyle et al., 2019; Ragno et al., 2023).
3) *Quality of life*: By supporting independence, emotional well-being, and continuous communication, TPRs improve quality of life (Beraldo et al., 2021; Koceski & Koceska, 2016).
4) *Cognitive support:* Some evidence suggests cognitive benefits, particularly for individuals with dementia, through increased mental stimulation and engagement (Michaud et al., 2007; Moyle et al., 2019).
5) *Health outcomes:* TPRs support virtual consultations, medication adherence, and mental health interventions, contributing to better health outcomes (Cortellessa et al., 2017; Sorrentino et al., 2020).
6) *Physical activity:* TPRs can guide older adults in exercise and rehabilitation routines, promoting mobility, strength, and physical wellness (Almeida et al., 2022; De Benedictis et al., 2022).
7) *Cost-effectiveness:* By reducing reliance on continuous in-person care, TPRs may help lower healthcare costs and improve resource efficiency (Ragno et al., 2023).
8) *Privacy and security:* The use of TPRs raises significant privacy and security issues, necessitating the implementation of strong technical safeguards (Hung et al., 2022).

In sum, TPRs offer strong potential to enhance older adults' well-being, though broader adoption depends on usability, ethical safeguards, and long-term evaluation.

RQ3: What are the key technological features of TPRs used in elderly care, and how do these features influence user acceptance and engagement?

Telepresence robotics is rapidly advancing, driven by developments in AI, machine learning, and hardware design. In elderly care, effective TPRs incorporate features such as audiovisual communication, intuitive user interfaces, remote control, obstacle detection, autonomous docking, adjustable height, and customizable functionality to accommodate diverse user needs (Ballesteros et al., 2019; Casiddu et al., 2015; Loza-Matovelle et al., 2019; Sorrentino et al., 2020).

Recent innovations focus on improving accuracy, usability, reliability, and adaptability to domestic environments. Enhanced obstacle detection, floor pattern recognition, and improved maneuverability are central to optimizing performance. Addressing sensor errors and physical limitations remains a key challenge (Casiddu et al., 2015; González-Jiménez et al., 2012; Sorrentino et al., 2020).

User acceptance is closely linked to the perceived ease of use and reliability. Complex or unintuitive interfaces, high latency, and poor connectivity contribute to user frustration and decreased engagement (Loza-Matovelle et al., 2019). Hybrid control models have been introduced, integrating caregiver or software support while preserving user autonomy (Koceska et al., 2019). Features such as simplified interfaces, large buttons, and voice commands enhance usability for users with sensory, cognitive, or mobility impairments (Casiddu et al., 2015; Ballesteros et al., 2019).

Training and support are crucial for adoption, especially among less tech-savvy older adults; simple interfaces boost satisfaction and engagement (Kiselev et al., 2015).

Semi-autonomous interaction and robotic-mediated communication represent promising approaches, particularly in clinical and long-term care settings. When thoughtfully designed, TPRs can effectively enhance quality of life by supporting communication, independence, and emotional well-being.

RQ4: What empirical evidence exists regarding the impact of TPRs interventions on cognitive functioning, emotional well-being, and quality of life among older adults?

Evidence on the impact of TPRs on cognitive functioning, emotional wellbeing, and quality of life in older adults remains limited and methodologically inconsistent. Nonetheless, existing studies report generally positive outcomes (Cesta et al., 2016; Koceski & Koceska, 2016; Michaud et al., 2007).

TPR interventions have been associated with improvements in attention, memory, problem-solving, and executive function through cognitively stimulating activities, social engagement, mental exercises, and access to educational resources (Cesta, 2013; Beraldo et al., 2020; Hiyama et al., 2017; Chen et al., 2013; Koceski & Koceska, 2016).

Studies suggest TPRs can enhance mood, reduce anxiety, and alleviate loneliness by facilitating virtual social interaction, maintaining social ties, and providing companionship (Cesta et al., 2016; Cortellessa, 2017; Reis, 2018; Zhang, 2018).

TPRs support daily activities, education, communication, and inclusion, contributing to improved quality of life and high user satisfaction (Hiyama et al., 2017; Narasimha, 2017). Positive effects have also been observed in individuals with mild cognitive impairment or dementia (Tiberio et al., 2013; Boman & Bartfai, 2015).

Emerging approaches, such as shared-control systems, further aim to enhance the effectiveness of TPRs in supporting well-being among older adults with cognitive challenges (Beraldo, 2021).

RQ5: What critical research gaps remain in the study of TPRs in elderly care, and what opportunities do these gaps present for future investigation and innovation?

Current research on TPRs in elderly care reveals key gaps and future directions:

1. Rigorous studies are needed on TPRs' impact on cognition, emotional well-being, and quality of life (Addas, 2023; Smith et al., 2021).
2. Financial viability, scalability, and long-term sustainability require further evaluation (Boissy et al., 2007; Moyle et al., 2020).
3. Cultural, ethical, and privacy factors affecting acceptance remain underexplored (Hung et al., 2022; Mascret & Temprado, 2023).
4. Research should focus on personalization for specific conditions and disabilities (De Benedictis et al., 2022).
5. User-centered design and interface features need further investigation (Fiorini et al., 2020).
6. Enhancing social presence and emotional responsiveness is essential for user trust (Fraune et al., 2022).
7. Technical improvements in navigation, durability, and adaptability are needed (Mascret & Temprado, 2023).
8. Longitudinal studies should assess long-term effects on well-being (Winterstein et al., 2021).
9. Integration into existing care systems requires addressing operational and regulatory barriers (Hiyama et al., 2017).

Addressing these gaps will inform theory, guide implementation, and support evidence-based innovation in TPR-enabled eldercare.

4 Persona-based findings

The following subsections provide an account of the personas derived from interviews with caregivers (Section 4.1), medical professionals (Section 4.2), and elderly individuals (Section 4.3).

4.1 Caregivers

Based on semi-structured interviews conducted with 15 caregivers, six distinct personas were identified to reflect the diverse attitudes, experiences, and expectations regarding the integration of TPRs in elderly care settings. These personas vary across care environments, levels of technological familiarity, and motivational drivers, offering a view of the socio-technical dynamics that influence TPR adoption.

Each persona captures a representative caregiving profile and serves to highlight differing priorities and barriers associated with robotic integration.

Persona 1: Socially-oriented female caregiver open to TPRs
- *Setting:* Care home
- *Focus:* Enhancing residents' well-being and social interaction through TPRs.
- *Attitude:* Cautiously optimistic, open to training.
- *Challenges:* Limited technological exposure, residents' cognitive decline.
- *Goals:* Reduce social isolation, improve family communication.

Persona 2: Task-oriented female caregiver
- *Setting:* Care home
- Focus: Reducing workload and improving emergency responsiveness through technology.
- *Attitude:* Functional view of TPRs; secondary interest in social use.
- *Challenges:* Time constraints, resistance to technology.
- *Goals:* Streamline monitoring and caregiving efficiency.

Persona 3: Skeptical and tradition-oriented female
- *Setting:* Care home
- *Focus:* Prioritizes personal care and traditional methods.
- *Attitude:* Highly skeptical of TPRs' usefulness.
- *Challenges*: Lack of clarity about robot benefits, concerns about resident safety and ethical issues.
- *Goals:* Maintain dignity and human-centric care.

Persona 4: Human-centered, resistant to change female
- *Setting:* Small care facility
- *Focus:* Preserving direct, in-person interaction.
- *Attitude:* Disinclined to integrate robots; distrust in technology.
- *Challenges:* Space limitations, ethical/privacy concerns, perceived lack of added value.
- *Goals:* Ensure comfort and emotional support via personal interaction.

Persona 5: Tech-positive and experienced male
- *Setting:* Care home
- *Focus:* Enhancing both social and practical caregiving tasks with TPRs.
- *Attitude:* Experienced with and receptive to TPRs.
- *Challenges:* Limited robot functionality, resistance from residents.
- *Goals:* Improve communication, reduce isolation, support staff workload.

Persona 6: Female home caregiver with conditional optimism
- *Setting:* Home care
- *Focus:* Using TPRs to assist in care and reduce elderly isolation.
- *Attitude:* Cautious but sees potential if implemented appropriately.
- *Challenges:* Elderly resistance, infrastructure limitations, privacy concerns.
- *Goals:* Foster emotional bonds, increase safety and independence via remote monitoring.

The persona analysis revealed several common themes that transcend individual caregiving profiles:
- *Motivational drivers.* A shared emphasis on improving resident well-being, maintaining dignity, enhancing caregiving efficiency, and strengthening communication with family members.
- *Key challenges.* Limited technological experience among caregivers, infrastructure constraints, especially in home settings, ethical concerns regarding privacy and autonomy, cognitive impairments among older adults impeding effective TPR use.
- *Desired robot features.* Simplicity, safety, user-friendly interfaces, emotional engagement, and support for both social and practical tasks.
- *Training needs.* Practical, hands-on guidance for both caregivers and residents; ongoing support.

This persona framework offers an understanding of the complex landscape of caregiver attitudes toward TPRs. It serves as a foundational tool for guiding user-centered design, deployment strategies, and training programs tailored to the real-world needs and concerns of caregivers. Recognizing and accommodating these diverse perspectives is essential for ensuring successful and ethical integration of TPRs in elderly care environments.

4.2. Medical professionals

Interviews with 15 medical professionals, including nurses, physiotherapists, internal medicine doctors, and educators, revealed a spectrum of perspectives on the use of TPRs in elderly care. Through a persona-driven analysis, three representative personas were constructed to capture key differences in attitudes, technological familiarity, and readiness for adoption. While many participants shared overlapping motivations and concerns, generational and experiential differences significantly influenced their views on the potential of TPRs in healthcare contexts.

Persona 1: Tech-comfortable female nurse and educator
- *Profile:* Female nurse and educator, 35 years old, with 10+ years in elderly care.
- *Environment:* Hospital, home care, and educational settings.
- *Technological outlook:* Comfortable with technology; limited experience with TPRs.
- *Goals:* Promote emotional and social well-being for elderly patients. Use TPRs to increase access

to care while preserving human connection. Encourage co-development of robots with elderly users for usability and trust.
- *Challenges:* Cognitive limitations in elderly patients hinder remote interaction. Financial and training barriers to adoption.
- *Concerns:* Ethical and privacy risks, especially in dementia care. Navigation in cluttered homes, trust in automation.
- *Desired features:* User-friendly interface, high-quality video/audio, health monitoring tools. AI-driven companionship, customizable robot design and voice. Integration with medical records and emergency support functions.
- *Training needs:* Interactive tutorials for caregivers and patients. Technical support, privacy training, and slow, supported introduction for elderly.
- *Success indicators:* Increased elderly engagement, improved care outcomes, family satisfaction, and national-level trust programs.

Persona 2: Low-tech female physiotherapist and nurse
- *Profile:* Female physiotherapist, aged 56, with 20+ years in rehabilitation and nursing.
- *Environment:* Nursing homes, in-home care, rehab centers.
- *Technological outlook:* Limited technological comfort and no TPR experience.
- *Goals:* Facilitate communication and motivation for elderly clients. Prevent mental isolation through meaningful interactions.
- *Challenges:* Poor digital literacy among elderly patients. Safety risks and cost barriers in TPR integration.
- *Concerns:* Suitability for dementia patients. Risk of injury or distress from unfamiliar or intimidating robots. Data privacy and lack of emergency responsiveness.
- *Desired features:* Compact, intuitive design; safe for small and cluttered spaces. Real-time communication; monitoring of vitals like temperature, blood pressure.
- *Training needs:* Practical workshops for staff. Continuous support and privacy training.
- *Success indicators:* Improved social engagement and reduced loneliness. Positive usability feedback from both elderly and staff.

Persona 3: Senior female physician skeptical of TPRs
- *Profile:* Female doctor, aged 82, with ~50 years in internal and palliative care.
- *Environment:* Nursing and care clinic.
- *Technological outlook:* Very limited; only basic computer and smartphone use. No hands-on experience with TPRs; limited exposure through AI testing in ward.
- *Challenges:* Strongly skeptical of TPR feasibility in elderly care and believes elderly cannot realistically adapt to robots due to cognitive decline.
- *Concerns:* Criticizes impersonality and high cost of TPRs.
- *Desired features:* Functional assistance (e.g., carrying food, delivering packages). Support communication when human staff are unavailable.
- *Training and success metrics:* Unable to specify due to lack of knowledge or experience.

The persona analysis highlighted a number of common motivations, barriers, and design requirements across professional roles and settings:
- *Motivational drivers.* Maintain emotional well-being of elderly patients, increase access to care without compromising human touch, use TPRs as supplementary tools rather than replacements for personal care.
- *Key challenges.* Technological unfamiliarity among elderly users, infrastructure and financial constraints, persistent ethical and privacy concerns.
- *Desired robot features.* Simplicity and ease of use, safe operation in constrained environments, adaptability for cognitively or physically impaired individuals.
- *Implementation needs.* Gradual, staged integration of TPRs into care workflows, hands-on training for both caregivers and care recipients, participatory, user-centered design and continuous technical support.

This analysis underscores the heterogeneous landscape of professional attitudes toward TPRs in elder care. While some healthcare professionals see strong potential for enhancing access and well-being, others, particularly older or more traditionally trained staff, express skepticism rooted in practical, ethical, and generational concerns. These findings highlight the need for tailored strategies that address both readiness and resistance within professional communities, ensuring that TPR implementation is inclusive, ethical, and grounded in real-world care practices.

4.3. Elderly individuals

To explore the diversity in needs, capabilities, and expectations among the elderly population, five personas were developed using thematic analysis of interview data. These personas represent a spectrum of health conditions, social settings, and technological familiarity, offering insight into how TPRs might enhance their well-being and autonomy.

Persona 1: Technologically confident female multigenerational resident
- *Age:* 72

- *Living:* With daughter and grandchildren abroad.
- *Health:* Fair, suffers from high blood pressure; easily fatigued.
- *Tech comfort:* High; daily smartphone and social media user.
- *Goals:* Save time and energy for herself, overcome language barriers.
- *Challenges:* Fatigue from daily chores, unfamiliar cultural context.
- *Concerns:* Privacy, robot safety in household spaces, uncanny appearance.
- *Desired features:* Multilingual support, household assistance, translation.
- *Training:* In-person demonstration preferred, expects regular updates.

Persona 2: Independent but socially isolated female

- *Age:* 74 |
- *Living:* Alone; widowed.
- *Health:* Good mobility, hearing and vision impairments. uses aids.
- *Tech comfort:* Moderate, learned from grandchildren.
- *Goals:* Reduce loneliness, feel closer to family.
- *Challenges:* Distrust of online privacy and data security.
- *Desired features:* Simple interface, reminders, video calling.
- *Training:* Hands-on with family present, 24/7 phone support preferred.

Persona 3: Autonomous but technologically hesitant male

- *Age:* 65
- *Living:* Alone in suburbia, limited support network.
- *Health:* Mild hypertension and back pain.
- *Tech comfort:* Basic, uses smartphone, unfamiliar with assistive tech.
- *Goals:* Maintain autonomy, improve family contact, manage health tasks.
- *Challenges:* Tech complexity, privacy concerns, dependency fears.
- *Desired features:* Voice control, health monitoring, entertainment.
- *Training:* Short tutorials with caregivers, automated guidance prompts.

Persona 4: Enthusiastic but physically dependent female

- *Age:* 75
- *Living:* On a farm with extended family.
- *Health:* Wheelchair user due to osteoarthritis.
- *Tech comfort:* High, very open to technology.
- *Goals:* Lighten the family's caregiving burden, increase self-reliance.
- *Challenges:* Severe mobility limitations.
- *Desired features:* Voice functions, vital sign monitoring, entertainment.
- *Training:* In-home, family-supported setup and training.

Persona 5: Independent female rural dweller with entrepreneurial spirit

- *Age:* 75
- *Living:* In the countryside with spouse.
- *Health:* Arthritis; walks with cane.
- *Tech comfort:* Very open, uses smartphone for voice/video calls.
- *Goals:* Reduce rural isolation, support daily tasks without reliance.
- *Challenges:* Loneliness from family migration, security concerns.
- *Desired features:* Gas detectors, audio reminders, video call screen.
- *Training:* In-person guidance, simple video tutorials, continuous support.

Across all personas, several shared themes emerged:

- *Motivational drivers.* Reduce loneliness and increase family interaction, maintain independence while managing health, gain support without replacing human relationships.
- *Key challenges.* Data privacy and cybersecurity, complexity of technology use, reliability and safety of robots in physical environments.
- *Desired robot features.* User-friendly interfaces with voice control, video calling, entertainment, and health monitoring, emergency alert systems and task reminders.
- *Training needs.* In-person, hands-on instruction with family or caregivers, ongoing support via telephone or regular visits, easy-to-follow user guides and troubleshooting aids.
- *Indicators of Success.* Improved communication and emotional connection, better health self-management, increased comfort and confidence using the robot.

These five personas reflect a multifaceted elderly population characterized by differences in digital literacy, health status, physical mobility, and social engagement. The findings underscore the need for adaptive, inclusive, and empathetic design principles in the development of TPRs for eldercare. The persona framework serves as a practical foundation for guiding user-centered innovation, deployment strategies, and policymaking that respects the diversity of older adult experiences and expectations.

5 Discussion

This study explored the potential of TPRs to support elderly individuals in Estonia by combining a systematic literature review with qualitative interviews analysed through a persona-driven framework. The findings reveal both promising opportunities and persistent challenges associated with TPR adoption across stakeholder groups - caregivers, medical professionals, and older adults - underscoring the complexity of integrating socially assistive technologies into eldercare systems.

5.1 Alignment with existing literature

The literature review confirmed that TPRs offer substantial potential to enhance social connectedness, facilitate remote monitoring, and promote autonomy among older adults (Moyle et al., 2014; Beraldo et al., 2018; Koceski & Koceska, 2016). These benefits were echoed in the interview findings, particularly among tech-positive caregivers and enthusiastic elderly users, who viewed TPRs as a way to reduce social isolation and improve quality of life. Similarly, the emphasis on usability, privacy, and reliability in the literature was reinforced by all interviewee groups, suggesting that these concerns remain central to successful deployment (Hung et al., 2022; Sorrentino et al., 2020).

The literature also highlighted that user engagement and acceptance are closely tied to interface simplicity and adaptability (Casiddu et al., 2015), a point echoed in the personas developed in this study. Whether due to sensory impairments, cognitive decline, or limited digital literacy, many elderly participants favoured voice-controlled interfaces, large buttons, and customizable features that could be tailored to their needs.

5.2 Divergence across stakeholder groups

While all groups acknowledged the potential value of TPRs, attitudes toward implementation varied markedly.

Caregivers showed a spectrum of views, ranging from optimism about workload relief and enhanced communication to deep skepticism, particularly among those committed to traditional, human-centered care models. Many stressed the importance of hands-on training, and some were concerned about the emotional and ethical implications of replacing human interaction with robotic presence.

Medical professionals were more divided. Younger participants, especially those working across education and hospital settings, tended to be more open to co-developing solutions with older adults. In contrast, older clinicians expressed strong skepticism, often citing cognitive limitations, ethical concerns, or lack of trust in automation.

Elderly individuals displayed perhaps the greatest variation. While some were eager to engage with TPRs to ease household burdens, enhance safety, or stay socially connected, others expressed concerns over data privacy, technical complexity, and dependency fears. Notably, those living in rural or socially isolated contexts expressed a higher willingness to adopt TPRs if the tools aligned with their lifestyle needs and provided practical assistance.

This divergence suggests that TPR integration cannot follow a one-size-fits-all approach. Instead, design and implementation strategies must be grounded in personalization, trust-building, and contextual sensitivity.

5.3 Barriers to adoption

The study identified a consistent set of barriers across stakeholder groups:

- Technological unfamiliarity and resistance, especially among older caregivers and medical professionals.
- Ethical concerns related to privacy, autonomy, and the impersonality of robotic interactions.
- Infrastructure and financial limitations, particularly in under-resourced home and rural settings.
- Lack of training and ongoing support, leading to uncertainty and underutilization of features.

These findings align with previous work (Fischedick et al., 2023; Niemelä et al., 2021) and underscore the need for robust policy frameworks, equitable funding mechanisms, and targeted educational programs that support both staff and elderly users in onboarding and integrating TPRs.

5.4 Implications for design and policy

The persona-driven analysis adds depth to the growing body of user-centered robotics research. By capturing individual variations in motivations, challenges, and feature preferences, the study supports several design and policy recommendations:

- Design for inclusivity. Interfaces must accommodate diverse abilities, from tech-savvy older adults to those with visual, cognitive, or motor impairments.
- Support autonomy without replacing human care: TPRs should augment, not replace, human relationships. This principle is particularly important in building trust among skeptical users.
- Embed empathy into interface behavior. Features such as AI-driven companionship, personalized voice options, and emotional responsiveness could enhance perceived warmth and acceptance.
- Ensure flexible training and support. Onboarding should be gradual, hands-on, and tailored. Ongoing access to technical help and family support is vital to long-term adoption.

- Develop context-aware strategies. Urban, rural, institutional, and home settings each require unique infrastructure and integration plans. A national strategy for TPR deployment in Estonia should reflect these contextual nuances.

6 Conclusion

This study demonstrates that telepresence robots hold transformative potential for supporting aging in place, enhancing caregiver efficiency, and improving social and emotional well-being among older adults. However, realizing this potential depends on deep contextual understanding, inclusive design, and ethical, user-centered implementation. Estonia's leadership in digital innovation provides a strong foundation, but attention to social care systems, equity, and stakeholder diversity will be essential in translating technological capability into meaningful impact.

The study also has limitations. The sample was geographically and demographically limited to the Estonian context, which may not generalize globally. Interviews, while in-depth, relied on hypothetical perceptions of TPRs rather than long-term use. Further quantitative validation and longitudinal field studies are needed to assess real-world impact over time.

Several avenues for future research emerge:
- Cross-cultural comparative studies to explore how sociocultural factors influence TPR acceptance.
- Longitudinal trials of TPR use in home and institutional settings to evaluate long-term effects on health, cognition, and emotional well-being.
- AI-enhanced personalization studies to tailor TPR behaviors and responses to individual needs.
- Cost-benefit analyses to inform funding decisions and sustainable implementation models.
- Co-design approaches involving older adults in iterative TPR development cycles.

Acknowledgments

This paper is based on empirical research conducted at Tallinn University as part of the LIFE (*Learning in Interdisciplinary Focused Environment*) initiative titled "Enhancing Elderly Care Through Telepresence Robots I" in spring 2024 and "Enhancing Elderly Care Through Telepresence Robots II" in autumn 2024.

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