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THE USE OF TECHNOLOGY IN THE REMOTE ASSESSMENT OF MATURE AND OLDER ADULTS

DOCTORAL THESIS SUMMARY

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1. The fundamental problem

Digital health was already an emerging trend before COVID-19 but saw significant acceleration due to the pandemic (Keesara et al., 2020). The issue of digital health inequalities, long debated, also gained prominence during this period. A key concern is the digital health paradox—the uneven ability of different social groups to benefit from digital transformation (van Kessel et al., 2022).

Older adults, a demographic with high rates of chronic illness, disability, and social isolation, are a primary target for digital health solutions (Győrffy et al., 2023). However, these solutions require substantial further research before they can be widely adopted by older adults and their caregivers. While COVID-19 led to unprecedented increases in internet use among older adults in many countries (e.g., Patyán et al., 2021), international trends show that they still lag behind younger populations in digital health technology adoption, particularly those with lower education levels or living in smaller communities (Charness & Boot, 2022). In terms of access, skills, and engagement, older adults report lower usage but higher levels of "technostress" and a perception that digital health technologies are "useless" (Győrffy et al., 2023). Technostress refers to the stress caused by interactions with digital systems (Bahamondes-Rosado et al., 2023). A systematic review on internet use among older adults in China found that gender, education, socioeconomic status, and physical and psychological conditions all influence usage (Shi et al., 2023).

Gender disparities in digital skills are also evident. While internet use among men and women is nearly equal in the 24–54 age group in the UNECE region, fewer women aged 55–75 use the internet compared to men (UNECE, 2023). In EU countries, women aged 55–74 are half as likely as men of the same age—or younger women—to possess at least basic digital skills.

This research is motivated by the potential of digital technology to mitigate the challenges associated with aging, including functional decline, chronic diseases, and changes in social networks. The successful implementation of these technologies depends on an accurate understanding of older adults' digital competencies and the development of user-centred solutions.

Older adults are less likely to use technology in daily activities and communication compared to younger generations due to gaps in digital skills and limited internet access (Petracca et al., 2020). Studies show that this population primarily uses basic phone functions, such as making calls or checking the time, while avoiding advanced features due to a lack of familiarity (K. Chen et al., 2013). This digital divide is influenced by factors such as low motivation, limited material access, and insufficient digital competencies (Kwong, 2015). Even when they acquire digital knowledge, many older adults hesitate to use technology due to resource constraints, physical and cognitive limitations, and a fear of making mistakes (K. Chen & Chan, 2014).

Another significant challenge is the accessibility of digital devices and the internet. Having a stable connection and compatible devices is essential for digital inclusion, yet many

older adults face financial barriers and difficulties in learning how to use technology (Khan & Loh, 2022). These limitations contribute to increasing social inequalities and the marginalization of this demographic in an increasingly digitalized world (H. Chen et al., 2023). In addition to structural barriers, personal attitudes also play a crucial role in technology adoption. Many older adults continue to prefer traditional communication methods, such as phone calls or print media, perceiving digital alternatives as unnecessary or unsafe (Bertolazzi et al., 2024; Gallistl et al., 2021).

Beyond mere usage, digital technology can support the process of active aging, which includes physical, cognitive, psychological, and social engagement. This process is closely linked to life satisfaction and quality of life in older adults (Marsillas et al., 2017; Stenner et al., 2011). Digital tools can facilitate independent living, social participation, and intergenerational relationships (Bar-Netzera & Bocoș, 2016; Rossi et al., 2014), but their impact depends on how well they are designed to meet the cognitive and physical needs of older users (Thalassios et al., 2019; Walker & Maltby, 2012).

Regarding caregivers, technology has significantly improved care coordination and the monitoring of older adults' health status, reducing uncertainties and facilitating communication (Allemann & Poli, 2020; Ruggiano et al., 2019). However, the implementation of these solutions must be critically evaluated, as they can introduce new challenges, such as increasing caregiver burden or difficulties in adapting to new digital systems (Chelongar & Ajami, 2021; Zonneveld et al., 2020).

To better understand why older adults, accept or reject digital technology and how their adaptation to new solutions can be improved, it is essential to investigate their digital competencies and existing barriers. Age is a major factor in the digital divide, but education level and income also influence access to and use of technology (Drabowicz, 2021; Guzek & Kowalska, 2020). According to the Technology Acceptance Model (TAM), perceived usefulness and ease of use determine the likelihood of adopting technology (Ahmad et al., 2020; K. Chen & Chan, 2014). However, habits and social norms can hinder the transition to digital solutions, particularly in areas such as communication and access to healthcare services (Herzlinger, 2006; Esmaeilzadeh, 2020; Khan & Loh, 2022).

This thesis explores these challenges and opportunities through a series of interconnected studies aimed at providing a comprehensive perspective on digital competencies, technology acceptance, and the impact of digital solutions on the well-being of older adults. The included studies are:

1. Self-assessment of digital competencies in older adults.

2. The effectiveness of the ReMember-Me system in supporting cognitive function.
3. The inter-instrument reliability of the Squegg® smart dynamometer compared to the Jamar® hydraulic dynamometer.
4. Determinants of technology adoption in older adults.
5. The relevance of new technologies for seniors and their caregivers.
6. Digital approaches to supporting the mental well-being of older adults.
7. Why do seniors accept or reject new technologies?

This research aims to identify the key issues and challenges associated with older adults' use of technology, as well as to formulate solutions that can help developers optimize and adapt these technologies to better meet users' needs.

2. Hypotheses

This thesis explores the adoption and impact of digital technologies on older adults through seven interconnected hypotheses:

1. Self-assessment of digital competence may lack reliability, necessitating validation through objective measures. Discrepancies between self-reported and objective assessments could influence the design of digital interventions (Study 1).
2. Do digital interventions, such as the ReMember-Me system, enhance cognitive function and well-being in older adults experiencing early cognitive decline (Study 2).
3. Innovative digital tools, such as the Squegg® smart dynamometer, can provide reliable physical function measurements comparable to standard devices (Study 3).
4. Key determinants of technology adoption influence how older adults accept or reject new technologies, shaping their willingness to engage with digital solutions (Study 4).
5. The perceived relevance of new technologies for older adults and their caregivers affects adoption and use, highlighting the need for solutions tailored to their needs (Study 5).
6. Digital approaches can support mental well-being in older adults, offering solutions to improve quality of life and social engagement (Study 6).
7. Understanding how older adults accept or reject digital technologies contributes to developing a senior-oriented technology acceptance model, informing the design of age-inclusive digital solutions (Study 7).

These hypotheses aim to identify the barriers and facilitators of digital technology adoption among older adults and their caregivers, providing insights for optimizing technological solutions to better align with their needs and preferences.

3. Objectives

The thesis has several objectives:

1. To evaluate the reliability of self-assessed digital competence by comparing self-reported measures with objective assessments, identifying discrepancies that could impact the design of digital interventions (Study 1).
2. To assess the effectiveness of personalized digital interventions, such as the ReMember-Me system, in improving cognitive function and well-being in older adults with early cognitive decline (Study 2).
3. To validate the reliability of innovative digital tools, such as the Squegg® smart dynamometer, by comparing their measurements of physical function with those of standard assessment devices (Study 3).
4. To identify the key factors influencing technology adoption among older adults, examining how these determinants affect their acceptance or rejection of digital solutions (Study 4).
5. To analyse the perceived relevance of new technologies for older adults and their caregivers, investigating its impact on technology adoption and sustained use (Study 5).
6. To explore the role of digital solutions in supporting mental well-being, assessing their potential for improving quality of life and social engagement in older adults (Study 6).
7. To develop a senior-oriented technology acceptance model, based on an in-depth analysis of the factors influencing older adults' willingness to adopt digital technologies (Study 7).

These objectives aim to provide a comprehensive understanding of the factors influencing the adoption of digital technologies among older adults and their caregivers, with a focus on identifying barriers and facilitators. This will guide the development of more relevant, accessible, and user-friendly technological solutions, including the design of a senior-oriented technology acceptance model and the evaluation of digital solutions and devices.

4. Research methodology

The methodology includes a mixed approach, combining quantitative methods (experimental studies, statistical analyses) with qualitative methods (interviews, focus groups). Comparative studies, longitudinal assessments, and inter-instrument reliability analyses are used.

5. Summary of the chapters, following the chapter structure

5.1. Subjective vs. Objective Assessment of Digital Competence in a Population of Older Adults in Romania

Introduction (Hypothesis and Specific Goals)

Digital technology has the potential to help address age-related challenges, including declines in physical and cognitive abilities, chronic illnesses, and changes in social connections. An individual's proficiency in using computers and the internet plays a crucial role in technology adoption, which is linked to increased usage, favorable attitudes, and greater self-efficacy. While there is a wealth of research on digital competence in younger populations, there is a noticeable gap in inclusive design and research focused on older adults, with existing assessments often failing to account for the diverse abilities of users. This study aims to examine the reliability of self-assessment in evaluating digital skills among older adults by comparing self-reported competence with objective assessments based on the digital foundation skills framework.

Methods (Participants and Procedures)

This study utilized a between-subjects design to investigate the reliability of self-assessment for evaluating digital skills in older adults, comparing self-reported competence with objective evaluations using the digital foundation skills framework. The framework includes six domains and offers statements and practical examples to guide both self-assessment and objective evaluation. Data were collected from 51 Romanian participants aged 60 and above, with an online survey for the subjective assessment and laboratory testing for the objective assessment.

Results

The analysis revealed significant discrepancies between self-assessed and actual performance in three domains: digital foundation skills, communication, and problem-solving. However, participants were able to accurately assess their performance in handling information and content, conducting transactions, and ensuring safety and legality while online.

Discussion

Given the absence of a consistent trend of either overestimation or underestimation, it is recommended to rely on objective assessments for a more accurate evaluation of digital competence.

5.2. Auxiliary Technological Devices: The Reliability of the Squegg Device in Measuring Grip Strength in Older Adults

Introduction (Hypothesis and Specific Objectives)

Occupational therapists require reliable tools for conducting remote assessments and monitoring hand functionality. These assessments are essential for tracking progress, evaluating interventions, and setting goals related to patient independence. The aim of this study was to assess the inter-instrument reliability and concurrent validity of the Squegg® Smart Dynamometer and Hand Grip Trainer compared to the Jamar® Hydraulic Hand Dynamometer.

Materials and Methods (Participants and Methods)

This study used a repeated-measures design and was conducted in a clinic in Bucharest, Romania. Forty healthy middle-aged and older adults participated, all of whom were free from neuromuscular or orthopaedic conditions that could affect hand strength. Maximal grip strength (MGS) was measured on both hands using the Squegg and Jamar devices. Participants with odd-numbered IDs were measured first with the Squegg and then with the Jamar, while those with even-numbered IDs were measured in the opposite order.

Results

Paired-samples t-tests revealed no significant differences in overall mean MGS or the average MGS from three measurements on each hand between the two devices. Intraclass correlation analysis indicated good to excellent reliability between the instruments. Pearson correlation coefficients for measurements across all participants and hands showed strong consistency between the devices.

Discussion

The Squegg® Smart Dynamometer shows promise as a reliable tool for assessing grip strength in clinical settings, particularly for occupational therapists. The initial psychometric data provided by this study suggest that the Squegg can be effectively used in remote MGS measurements. Since grip strength is a key indicator of physical function in aging adults, accurate and reliable tools like the Squegg are crucial for assessing the impact of hand strength on daily activities and guiding treatment interventions.

5.3. Advancing User-Centred Design and Technology Adoption for Aging Populations: A Multifaceted Approach

Introduction (Hypothesis and Specific Objectives)

The global demographic trend towards an aging population requires a comprehensive approach to the development and adoption of assistive technologies tailored for older adults. This paper aims to summarize key challenges, strategies, and recommendations related to the complex landscape of technology use and acceptance among aging populations. A focus on user-centred design and co-creation is essential for creating effective assistive technologies. These approaches involve actively engaging older adults in workshops, focus groups, and design sessions to gather feedback, ensuring that the resulting technologies are accessible, intuitive, and meet their needs.

Engaging older adults in the technology development process is crucial for success. To ensure meaningful participation, factors like participant selection, cultural attitudes, and trust-building mechanisms must be carefully considered. Accurate evaluation of technological literacy among older adults is critical for the creation and implementation of digital solutions. Given the limitations of self-reported proficiency, objective measures are necessary to avoid biases and ensure reliable assessments of user capabilities.

Materials and Methods

This study was a literature review supplemented with insights from the implementation and evaluation of assistive technologies for older adults. The sources were selected from academic databases such as PubMed, Scopus, and Google Scholar using specific search terms related to assistive technologies, technology adoption, co-creation, digital literacy, and caregiver integration.

Selection criteria included articles from reputable scientific journals, reports from relevant international organizations, and empirical studies on the implementation of assistive technologies. Information was synthesized based on key themes identified in the literature, focusing on determinants of technology adoption and best practices from previous implementation experiences. This approach does not involve original data collection but aims to integrate existing knowledge and identify future research directions and practical applications.

Results

One of the key barriers to technology adoption among older adults is the fragmented digital landscape, which exacerbates the digital divide. This divide creates significant obstacles for older individuals seeking to engage with new technologies. The involvement of caregivers plays a pivotal role in technology acceptance. Incorporating the caregiver perspective into adoption models can reduce barriers and encourage active participation in assistive technologies.

Discussion

To advance technology adoption for older adults, it is crucial to prioritize user-centred design, integrate caregivers into the adoption process, and foster interdisciplinary collaboration. These strategies can significantly enhance technology acceptance and improve the quality of life for aging populations in an increasingly digital world. Collaborative research efforts and the establishment of robust standards are essential to overcoming societal inequalities and promoting the adoption of assistive technologies that meet the evolving needs of older adults.

5.4. Digital Cognitive Assessments and Technological Solutions for Supporting Older Adults

Introduction

Aging often leads to cognitive decline, ranging from subjective cognitive decline (SCD) to mild cognitive impairment (MCI) and dementia. Around 27% of individuals with SCD progress to MCI, and 14% to dementia, with MCI affecting 15-20% of those over 60 and progressing to dementia at an annual rate of 8-15%. Given the limited efficacy of pharmacological treatments, cognitive interventions have gained importance in preserving cognitive functions and supporting daily activities.

Computerized cognitive interventions (CCI) offer advantages such as personalization, immediate feedback, and immersive experiences. Meta-analyses show CCIs can enhance cognitive function in older adults with MCI, particularly in early intervention stages.

Ambient Assisted Living (AAL) technologies support aging in place by integrating ICT, assistive devices, and smart home solutions to promote independence, social connections, and well-being. ReMember-Me, an AAL project, targets early cognitive decline by combining monitoring, detection, and personalized training. It provides continuous cognitive assessments, social engagement, and holistic exercises, supporting brain health through personalized recommendations. By facilitating early detection and prevention, ReMember-Me aligns with older adults' routines, enhancing usability and acceptance while involving caregivers in health management.

Patients and methods

Data were analysed using SPSS v25 (IBM Corp., 2017), with statistical significance set at $p < 0.05$. Demographic data are presented in Table 1, while means and standard deviations for all tests (Stroop Words, Stroop Colors, Stroop Words-Colors, ACE-III, Well-being, and Loneliness) at baseline and post-intervention are shown in Table 2 and Figures 1–6. Tests for

skewness, kurtosis, and normality are summarized in Table 3. Stroop test scores, assessed using the Shapiro-Wilk test, were normally distributed at both time points, whereas ACE-III, Well-being, and Loneliness scores did not follow a normal distribution.

As part of an AAL project involving multiple partners, data were collected from healthy older adults across three countries—Romania, Cyprus, and Italy. 20 adults (aged 60+) were recruited from each site's geriatric clinic and randomly assigned to either the intervention or control group. The final sample included 25 participants in the intervention group and 27 in the control group.

Results

The study results suggest that the intervention had no significant impact on cognitive performance or emotional well-being compared to the control group. No meaningful changes were observed in Stroop word, Stroop colour, or Wellbeing tests, indicating no intervention effect on these variables.

However, significant differences were found in Stroop word-colour, ACE-III, and Loneliness scores between baseline and post-intervention assessments. Since these changes occurred in both groups, they are likely due to test-retest effects rather than the intervention itself. Prior research has shown that even individuals with Alzheimer's can exhibit practice effects over short periods, making these effects even more probable in healthy older adults assessed within two months.

Initial well-being differences among participants may have influenced their response to the intervention, highlighting the need for better participant selection or statistical adjustments in future studies. Additionally, cross-country differences showed that Cypriot participants had lower education levels and higher average ages, factors known to affect cognitive performance and requiring further investigation.

While the control group design helped rule out confounding variables, it could not eliminate test adaptation effects. The intervention may also have effects not captured by the tests used, suggesting the need for additional measures in future research.

Discussion

In conclusion, while no significant intervention effects were found, the study underscores the importance of accounting for testing effects and baseline participant characteristics. Future research should consider personalized interventions tailored to cognitive abilities and motivational factors, explore combined cognitive and psychological approaches, and use longitudinal designs to assess long-term impacts. This will help develop

more effective programs that support cognitive function, emotional well-being, and quality of life in older adults.

5.5. The Relevance of New Technologies for Seniors and Their Caregivers

Introduction

In recent years, a variety of innovative technologies have emerged, aimed at offering solutions to enhance the daily lives of older adults and help them maintain their independence at home. With the increasing aging population, there is an urgent need for products and services that address the specific challenges seniors face. This study investigates the factors influencing the adoption of assistive technologies among seniors, focusing on the role of family support, psychological health, and consumer behaviours. The primary objective is to understand the relationships between family involvement, awareness of assistive technologies, and gender differences in adopting technology. The study also aims to evaluate the psychological status of seniors as a critical determinant of their technological needs.

Materials and Methods

This research employs a questionnaire-based survey methodology, with data collected from 105 senior participants over May and June 2022. The survey was designed to identify the key factors influencing technology adoption among seniors, including family support, psychological status, and gender differences in selecting technology. Respondents were asked about their experiences, attitudes, and the perceived relevance of assistive technologies in their lives. The data collected were then analysed to identify patterns in seniors' behaviour regarding technology use and adoption.

Results

The analysis of the survey data produced several key findings:

1. Strong family support was significantly linked to a higher demand for technology-assisted care solutions among seniors.
2. There was a noticeable lack of awareness and usage of assistive technologies among the senior population.
3. The relevance of technology for seniors was closely tied to their psychological status, with those in better mental health being more likely to adopt technology.
4. Consumer behaviour was influenced by both facilitating and limiting factors, including trust in technology and perceived ease of use.
5. Gender differences were apparent in the selection and preference for technologies, indicating that men and women may approach technology adoption differently.

Discussions

The results of this study highlight several significant issues regarding technology adoption by seniors. One key conclusion is the role of family support in facilitating the acceptance of assistive technologies. This finding emphasizes the importance of involving family members in supporting and encouraging seniors to adopt new technologies. Furthermore, the lack of awareness and use of assistive technologies among seniors suggests the need for more educational initiatives and outreach programs to improve access and knowledge of these solutions.

The study also stresses the importance of psychological health as a critical factor in determining seniors' openness to adopting technology. This suggests that assistive technologies should be designed with consideration of seniors' emotional and mental well-being. Additionally, the gender differences observed in technology preferences highlight the need for gender-sensitive approaches in the development and marketing of assistive technologies.

Overall, the research underscores the complexity of factors that influence technology adoption among older adults, including social, psychological, and cultural elements. These insights are crucial for developing more inclusive and accessible technologies that cater to the diverse needs of the aging population. Future research should explore these factors further and examine how they can be integrated into the design and implementation of assistive technologies for older adults.

5.6. Digital Approaches to Supporting the Mental Well-being of Older Adults

Introduction (Hypothesis and Specific Objectives)

The potential for technology to improve the mental health and overall quality of life for older adults—either individually or as a group—is significant, particularly when addressing their unique needs. This paper aims to initiate a conversation and raise awareness about the importance of user engagement in technology, serving as a starting point for future research and theory development in this area. The central objective is to explore how user engagement indicators (UEIs) have been assessed in existing studies, and to differentiate between objective and subjective criteria used in their evaluation.

Materials and Methods

A systematic review was conducted across several academic databases, focusing on identifying how different studies have investigated user engagement indicators (UEIs). The review aimed to compare and contrast the methodologies used, with a specific focus on distinguishing between objective and subjective criteria in the assessment of UEIs. This

review process involved examining various experimental studies that measure user engagement in digital interventions for older adults.

Results

The review found significant variation across studies in terms of the combination of subjective and objective criteria used to assess UEIs. No two studies employed the same set of criteria, highlighting the lack of standardization in how engagement is measured in this field. The results suggest that the current approaches to measuring UEI are fragmented and inconsistent, with many studies lacking clear definitions and guidelines for data acquisition procedures.

Discussions

The findings underscore the challenges in developing standardized methods for assessing user engagement in digital interventions for older adults. The lack of a unified framework for measuring UEIs is a major limitation, as it complicates the process of drawing meaningful comparisons between studies and assessing the overall effectiveness of digital technologies. The fragmentation in existing research also points to the need for clearer data collection procedures and more rigorous methodologies to evaluate the outcomes of digital interventions.

Despite these challenges, the field of digital interventions for older adults is rapidly emerging, but it remains insufficiently explored and understood. The lack of standardized assessment criteria limits the ability to evaluate the benefits and risks associated with these technologies accurately. Therefore, it is essential to develop and theorize standardized indices and measurement techniques to better understand the impact of digital interventions on seniors' lives and to guide future research in this area. Establishing these standards will be crucial for advancing the field and ensuring that technology effectively meets the needs of older adults.

5.7.Why Do Seniors Accept or Reject New Technologies?

Introduction

The global aging population necessitates a deeper understanding of technology acceptance among older adults, particularly in the context of gerontechnologies. Existing models such as the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) primarily focus on younger populations, leaving a research gap regarding seniors. This article proposes a new conceptual framework to explore why seniors accept or reject new technologies and gerontechnologies, with a

particular focus on the relationship between seniors and television, exemplified by the Senior-TV device, a new gerontechnological TV solution.

The hypothesis is that a more refined, multifaceted model that incorporates seniors' behavioural intentions toward technology can more accurately capture the complexity of technology adoption in the older population. The specific objectives are: 1) To use a gerontographics approach for a deeper understanding of seniors' needs, 2) To enhance and refine existing technology acceptance models for seniors, 3) To explore how seniors perceive the relevance of technology in their lives, and 4) To integrate diverse perspectives from both formal and informal caregivers to better understand their influence on the seniors' relationship with technology.

Materials and Methods / Participants and Methods

This study combines a literature review with field research, drawing data from a purposive sample of 148 seniors. A survey was conducted from 2017 to 2018 in Slovenia, Romania, and Cyprus, followed by a follow-up survey with 105 seniors from February to April 2019. The focus is on understanding seniors' acceptance of new technologies, particularly the Senior-TV device, by applying a gerontographics approach to analyse their needs, preferences, and technology usage behaviours. Both quantitative and qualitative methods were used to gain comprehensive insights into factors influencing technology adoption. Key variables examined included the perceived relevance of technology, seniors' openness to trying new devices, and the role of caregivers in shaping their attitudes toward technology.

Results

The results indicate that seniors' willingness to adopt new technologies is strongly influenced by the perceived relevance of those technologies, their personal interests, and the degree to which the technology meets their specific needs. The gerontographics approach enabled the segmentation of seniors into categories based on their technology adoption behaviours and preferences. There was considerable variation in how seniors engaged with different types of technologies, with TV-related devices like Senior-TV receiving positive responses when aligned with seniors' lifestyles and daily activities. Additionally, the research highlighted the critical role of both formal and informal caregivers in shaping seniors' perceptions and acceptance of technology.

Discussion

The findings underline the importance of adopting a more nuanced approach to technology acceptance models for older adults. By expanding on traditional models like TAM

and UTAUT, this research offers a framework better suited to the unique needs and preferences of the senior population. The results suggest that understanding seniors through a gerontographics lens enables more precise segmentation and provides valuable insights into how technology can be tailored to improve their quality of life. Moreover, incorporating caregiver perspectives into the technology adoption process leads to a more comprehensive understanding of seniors' technology use. This study highlights that products designed to align with seniors' interests and daily routines have a greater likelihood of success. The proposed model provides a foundation for future research and product development, emphasizing the multifaceted nature of technology adoption among older adults.

6. Conclusions

This paper explored various aspects of the relationship between older adults and digital technologies, offering a comprehensive perspective on the challenges and opportunities in this field. The seven studies presented addressed interconnected themes, from digital competence assessment and validation of new measurement tools to analysing factors influencing technology adoption and the impact of digital interventions on the cognitive and mental health of seniors and their caregivers.

The first study, "Subjective vs. Objective Digital Competence Assessment in Older Adults in Romania," highlighted the significant gap between self-perceived and actual digital competencies, emphasizing the need for objective assessments and interfaces tailored to this population's needs.

The second study, "Auxiliary Technological Devices: Reliability of the Squegg Device in Measuring Grip Strength in Older Adults," validated the Squegg as a viable alternative to traditional dynamometers, demonstrating the potential of new technologies to provide accessible, user-friendly health monitoring solutions both in clinical and home settings.

The third study, "Advancing User-Centered Design and Technology Adoption for Aging Populations: A Multifaceted Approach," emphasized the importance of co-creation strategies and cultural sensitivity in promoting the adoption of assistive technologies, calling for a multidimensional approach that directly involves seniors in the design process.
The fourth study, "Digital Cognitive Assessments and Technological Solutions for Supporting Older Adults," evaluated the effects of a personalized digital intervention on cognitive decline. Although no significant improvements were observed, the study highlighted the

importance of rigorously controlling for testing effects and baseline participant characteristics.

The fifth study, "The Relevance of New Technologies for Seniors and Their Caregivers," provided valuable insights into the preferences and needs of seniors regarding assistive technologies, highlighting gender, psychological status, and family context differences, and stressing the need for personalized approaches in the development and implementation of technologies.

The sixth study, "Digital Approaches for Supporting the Mental Well-Being of Older Adults," analyzed the engagement indicators of mental health apps for seniors. The findings emphasized the potential of digital interventions to improve mental health but also called for a more standardized approach to evaluating these interventions.

The seventh study, "Why Do Seniors Accept or Reject New Technologies?" proposed a framework for analysing seniors' relationship with new technologies using gerontographic segmentation. This study highlighted the importance of contextual factors, such as social integration and health status, in shaping seniors' attitudes toward technology.

Overall, these studies form a cohesive body of research addressing multiple facets of the interaction between seniors and digital technologies. They stress the need for a holistic approach that considers the diversity of seniors' needs, competencies, and contexts. The results suggest that to maximize the benefits of digital technologies for this population, close collaboration is essential among developers, researchers from various disciplines, healthcare providers, and, most importantly, the seniors themselves.

Future research should focus on developing more personalized interventions that account for the heterogeneity of the older adult population. Additionally, there is a need for further exploration of the long-term impact of technology use on seniors' physical, cognitive, and emotional well-being. The ethical and privacy aspects of technology use among seniors also remain important areas for investigation.

In conclusion, this series of studies provides a solid foundation for understanding and improving the interaction between seniors and digital technologies. They highlight both the potential of these technologies to enhance the quality of life for seniors and the complex challenges associated with their development, implementation, and evaluation. Continuing research in these directions will help create a more inclusive technological ecosystem better suited to the needs of the older adult population, significantly improving their quality of life in the digital age.

Personal Contributions

This work significantly advances knowledge on digital competencies, assistive technologies, and cognitive digital interventions for older adults and their carers. It highlights gaps in literature and opportunities to improve clinical practice and technology design.

Study 1, on digital competence assessment, contributes by integrating self-assessments with objective measures, revealing discrepancies between self-perception and actual competence. This approach enhances the design of more accessible digital interfaces for older adults.

Study 2 validates the Squegg device, demonstrating its effectiveness in muscle strength monitoring compared to traditional tools, offering a more accessible and affordable alternative for continuous health monitoring at home.

Study 3 explores assistive technology adoption, emphasizing cultural sensitivity in design, which improves integration into daily life and increases adoption rates among seniors.

Study 4 discusses digital interventions for cognitive decline, highlighting the need for personalized approaches to be more effective in managing cognitive health over time.

Study 5 investigates seniors' perceptions and acceptance of new technologies, proposing an updated model of technology adoption that considers diverse needs and includes feedback from both seniors and caregivers.

Study 6 reveals that family support is crucial in the adoption of assistive technologies, with psychological status and gender influencing technology preferences.

Study 7 contributes to digital mental health interventions, emphasizing the need for standardized frameworks to assess user engagement and effectiveness.

The technical-economic implications show that while adopting digital technologies can enhance seniors' quality of life, it also presents significant economic challenges. Devices like Squegg could reduce healthcare costs by providing affordable alternatives for physical monitoring. Personalized interventions require substantial investment, but offer long-term savings by enhancing seniors' independence and reducing healthcare dependency.

Unresolved issues include addressing the complex relationship between digital competence and technology adoption across diverse socio-economic and regional groups. Further research is needed on integrating assistive technologies into seniors' daily routines and evaluating the long-term impact of digital interventions on cognitive and mental health.

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