

**Gerontechnology:
A Scoping Review of Telehealth and
Ageing in Place Initiatives for
Kaumātua with a Focus on Dementia
and Loneliness**

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Executive Summary

Brief Overview

As New Zealand rapidly approaches a super-aged society, with over 21% of the population estimated to be aged 65 and older by 2032, a vision for a sustainable future in New Zealand's super-aged society is needed. The challenge of supporting our Kaumātua (older Māori) becomes urgent as the resulting projected increase in demand for healthcare also escalates. This scoping review uncovers the potential of gerontechnology, telehealth and ageing-in-place innovations to not only address the pressing health needs of Kaumātua but to contribute to a dynamic, sustainable healthcare system that benefits all New Zealanders. The review emphasises the critical role of culturally driven, people focused technology that strengthens the connection between Kaumātua, their whānau, and their communities.

Key Findings

Innovative Gerontechnology for Independence and Wellbeing

Cutting-edge technologies such as telehealth, cognitive interventions, and assistive devices are transforming the way we care for older adults. These tools offer life changing benefits, promoting independence, boosting cognitive function, and enhancing social connections, while also reducing caregiver stress. For Kaumātua, these innovations support living at home and staying connected with whānau and iwi, preserving cultural identity while receiving care.

Addressing Barriers to Adoption

Despite the exciting promise of gerontechnology, challenges remain. The digital divide, low digital literacy, and privacy concerns must be tackled head-on. Many Kaumātua, particularly in rural areas, face obstacles in accessing and using these technologies. Culturally inappropriate solutions can hinder engagement, making it essential that we tailor these technologies to align with Māori values and traditions.

The Rauawaawa Kaumātua Charitable Trust Perspective

Rauawaawa, like other trusted community-led organisations can play a pivotal role in ensuring that gerontechnology resonates with the lived experiences of Kaumātua. From Rauawaawa's viewpoint, technology must go beyond just addressing physical and cognitive needs; it must foster social connection, uphold tikanga Māori, and reflect the deep-rooted values of manaakitanga (care), whanaungatanga (relationships), and tino rangatiratanga (self-determination). With trusted community-led organisations, at the forefront, the integration of gerontechnology can be an empowering, culturally relevant and meaningful journey, whilst also having a higher likelihood of success. As natural gathering places for Kaumātua, community-led organisations offer known spaces for collaboration, co-design, and testing of new innovations, making them excellent breeding grounds for digital innovation hubs that engage, educate, innovate and empower all older adults.

Recommendations for a Sustainable Future

Prioritising Culturally Relevant, People-Driven Solutions

Co-design gerontechnology solutions with Kaumātua and Māori communities to ensure they are culturally appropriate, accessible, and relevant is key. This approach will foster higher adoption and ensure the technology not only supports physical and cognitive health but strengthens cultural identity and social connectedness.

Leverage Global Expertise and Local Knowledge

By drawing on successful international models and relationships whilst also embedding local expertise including Māori knowledge and values, New Zealand can harness the best of both worlds. Collaborations across communities, agencies, academics and sectors with similar aspirations will ensure these technologies are adapted to the unique needs of our communities.

Strengthening Multi-Sector Leadership

To truly thrive in a super-aged society, New Zealand must foster collaboration between community organisations, academia, government, and the private sector. This united approach will ensure gerontechnology's growth and scalability, driving innovation that serves not only Kaumātua but the entire ageing population of today and tomorrow.

Building Infrastructure and Digital Literacy

Investing in digital literacy programs for Kaumātua and their whānau, along with enhancing infrastructure in rural and underserved areas, will be vital. By ensuring equitable access to telehealth and gerontechnology, we can create a healthcare system that reaches every corner of Aotearoa.

An Inspiring Future

As we approach the reality of a super-aged society, New Zealand stands at the brink of something extremely transformational and impactful. Fortunately, this is not a phenomenon that New Zealand is facing in isolation, there are several super-aged societies already paving the way successfully with the use of gerontechnology that we are able to follow and leverage off their investment and learnings. By investing in gerontechnology that is culturally grounded, people-driven, and collaborative, we can build a sustainable, equitable health system that empowers our Kaumātua to thrive. This is not just about addressing the challenges of ageing, it's about transforming healthcare, preserving cultural identity, and creating a future where technology and tradition go hand in hand to support our Kaumātua and our nation.

Introduction

Background Information

The World Health Organization has described the ageing of the global population as the most important medical and social demographic problem worldwide [73]. By 2050, the number of people aged 65 years and older globally is expected to double, reaching approximately 2.1 billion [66]. In New Zealand at present (2024), the population aged 65 and older represents approximately 17% of the population. By 2032 it is expected that New Zealand will have transitioned to a super-aged society (21% and more) [60], bringing a shift from a high prevalence of age-related conditions to a significant burden of chronic and degenerative disease which has sustainability implications for the health, welfare and housing systems. This growing trend is forecasted to continue to 2050, with an increase to nearly 25% of the projected population of 6 million [63].

Figure 1 below highlights the ageing population trend with 2026 and 2072 identified as the years in which the over 65 age group starts to exceed the 0-14 and 15-39 age groups respectively.

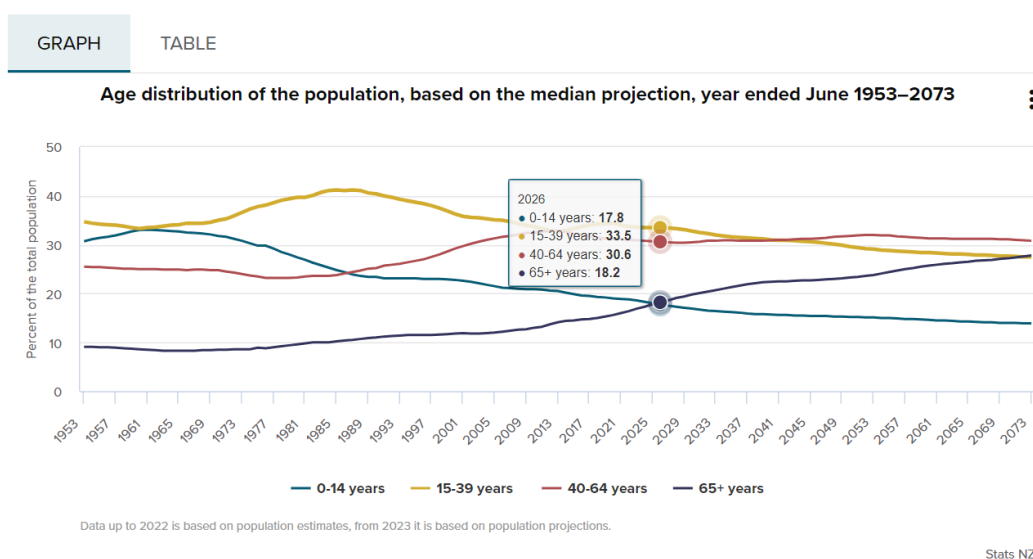


Figure 1: Age distribution of the population, based on the median projection, year ended 1953 - 2073

Source: [Stats NZ, 2022; One million people aged 65+ by 2028](#)

The United Nations (2024) note that preparation for such a society includes such measures as strengthening systems of health and long-term care, improving the sustainability of social protection systems, and relevant to this scoping review, investing in new technologies [67].

Gerontechnology, is a term that combines gerontology with technology, originating in the Netherlands in the 1990s. It is a creative, multidisciplinary solution that aims to address the ageing population challenge. By doing so, gerontechnology offers enormous potential to ensure better care and improved quality of life (QoL) for older adults [32] as well as promote

health, independence, and social engagement among the elderly. Gerontechnology has been developed out of necessity in super-aged societies like Japan and Germany, as a way to bring a cost-effective means of care provision to an ageing population and address the decreasing caregiver workforce [3].

For this scoping review, gerontechnology includes telehealth and other innovative initiatives that have been used to address some of the major challenges of ageing, particularly dementia, cognitive ability, social isolation, loneliness and ageing in place.

Telehealth also known as telecare and telemedicine involves the remote provision of healthcare using information and communication technology (ICT) [48]. Ageing in Place refers to the ability of older adults to live independently in their own homes. Having people remain in their homes and communities for as long as possible also avoids the costly option of institutional care [75]. There is a growing variety of research topics pertaining to ageing in place, range from housing and environment to health and technology [68]. Ageing in Place can be supported by various technologies, such as in the case of those with cardiovascular disease using smart home devices, assistive technologies, and remote monitoring systems, which enhance safety and independence [70].

Managing dementia and addressing loneliness for older adults through the literature highlighted initiatives that utilised Assistive Technology and Telecare (ATT), ICT-Based Cognitive Interventions and Socially Assistive Robots. In addition, interventions including commercially available, artificial intelligent voice activated Virtual Home Assistants (VHA) were also trialled [13].

Rationale

This scoping review aims to understand the potential benefits and challenges of gerontechnology in supporting older adults. It focuses on telehealth and ageing in place initiatives, particularly those assisting in dementia management and addressing loneliness among older adults/kaumātua. The ageing population in New Zealand presents significant challenges and opportunities for enhancing the health and well-being of our kaumātua (older Māori). Gerontechnology, which includes various technologies designed to support older adults, offers promising solutions that require evaluation.

This scoping review aims to map existing technologies that aid independent living and health management for older adults and seeks to identify gaps in current research and development, highlighting areas needing further work to better address the unmet needs of older adults. This assessment will provide valuable insights into how technological advancements can better support our kaumātua. Finally, this scoping review aims to provide recommendations that support the adoption and integration of effective gerontechnologies, promoting healthier, more independent, and socially connected lives for our kaumātua, as well as supporting a more sustainable health system as New Zealand progresses to a super-aged society.

Methodology

Summary of Methodology

The methodology for this scoping review on gerontechnology, ageing in place, telehealth, dementia, and loneliness among older adults was developed with the significant support of Ministry of Health Library staff. It involved searching databases including Ovid MEDLINE, PsycInfo, Embase, and Scopus using key terms related to ageing in place, independent living, telehealth, and gerontechnology.

The review focused on systematic and scoping reviews involving older adults and caregivers, looking at technological innovations, interventions for cognitive improvement, dementia care strategies, and efforts to reduce loneliness and social isolation. Only studies in English and relevant to community or healthcare settings were included.

The screening process included reviewing titles and abstracts to check for relevance, followed by full-text reviews of accessible studies. Data was extracted using a standard template that recorded such details as citations, study design, population characteristics, interventions, key findings, and policy recommendations. Endnote 20 and Excel were used to manage and organise the data. To ensure accuracy, two reviewers independently checked each study's title and abstract against the inclusion criteria, discussing any inconsistencies to minimise errors.

Findings

Summary of Findings

The key findings reveal that technology can significantly support older adults, particularly those with mild cognitive impairment (MCI) or dementia. Gerontechnology plays a critical role in enhancing the quality of life for older adults by improving independence, assisting daily activities, and reducing caregiver stress. Assistive technologies (ATs), such as intelligent assistive robots and digital tools, help maintain functioning, facilitate ageing in place, and alleviate caregiver burnout [10,24]. Additionally, social robots and ambient assisted living (AAL) technologies enhance the physical and mental well-being of older adults by supporting independent living and social engagement [21,3].

However, barriers to adoption, such as technology anxiety, system failures, and the digital divide, remain significant. Privacy concerns, cost, and usability issues also limit the effectiveness of these solutions. Policymakers should consider addressing these barriers through personalised training, stakeholder involvement, and ensuring cultural relevance [7].

Cognitive Health and Social Well-being

Interventions like ICT-based cognitive programs have demonstrated efficacy in improving cognitive function, reducing depression, and enhancing the quality of life for older adults, including those with dementia [9,16]. Tools such as serious games¹, musical mobile apps, and virtual health assistants (VHAs) have helped slow memory loss, improve cognitive abilities, and reduce loneliness [46]. However, privacy concerns and cost remain obstacles to widespread adoption of VHAs. Telehealth interventions have been particularly successful in managing medication adherence and improving cognitive function [18,55].

While cognitive training technologies have positively impacted both cognitive functioning and caregiver self-efficacy, the results on depression are mixed [16]. Technologies like robots and social media platforms have helped alleviate loneliness and psychological distress in older adults [50]. Additionally, non-pharmacological interventions, such as light therapy and the robotic seal PARO, have reduced anxiety, agitation, and depression while improving sleep [52,28].

Telehealth and Remote Monitoring

The COVID-19 pandemic highlighted the essential role of telehealth in maintaining care for older adults while reducing the risk of exposure to the virus [22]. Telehealth interventions, including home monitoring and treatment modification, have been effective in improving medication adherence and enhancing the well-being of both patients and caregivers [18,9]. Remote monitoring technologies such as passive remote monitoring (PRM), which gather data on daily activities, abnormal behaviours, and cognitive impairments, offer further support for independent living and ageing in place [53].

¹ A game designed for a primary purpose other than pure entertainment

Challenges and Opportunities

Despite the numerous benefits, challenges such as usability, privacy concerns, and technical difficulties persist. These issues often hinder the widespread adoption of technologies that otherwise show great promise in improving the safety, independence, and overall quality of life for older adults. Smart home modifications, including fall prevention systems and enhanced indoor accessibility, are valuable but often underutilised due to perceived mismatches between technology and user needs [39]. To ensure that older adults can fully benefit from these advancements, policymakers must address these challenges through targeted interventions and support mechanisms that prioritise ease of use and accessibility.

In conclusion, technologies like smartphones, tablets, and robots are beneficial for ageing in place, cognitive health, and caregiver support, but they face ongoing challenges related to usability, cost, and user acceptance. Addressing these barriers will be crucial in realising the full potential of gerontechnology to support independent living and reduce the burden on caregivers.

Limitations of Findings

While gerontechnology holds great promise in supporting older adults, particularly those with cognitive impairments, several barriers limit its widespread adoption. Key challenges include low digital literacy, privacy concerns, and usability issues, which make it difficult for older adults to effectively engage with these technologies. High costs and the complexity of assistive technologies further impede access, while ethical concerns around data security pose significant barriers to the adoption of telehealth and in-home monitoring systems.

Additionally, the inconsistent quality of research studies, the absence of standardised outcome measures, and a lack of longitudinal research hinder the ability to fully assess the long-term impact and sustainability of these interventions. Addressing these limitations will require targeted training programs, culturally relevant designs, and greater support for user-friendly, accessible technologies. A focus on overcoming these barriers is needed to ensure gerontechnology's full potential is realised for New Zealand's ageing population.

Barriers and Facilitators in Technology Use

While technology has the potential to significantly support older adults, particularly those with mild cognitive impairment or dementia, there are several barriers that impede its widespread adoption. Digital literacy, privacy concerns, usability issues, and cost are commonly reported obstacles [22,55]. Many older adults face challenges in accessing assistive technologies due to a lack of technical support and the complexity of the systems involved [26]. Furthermore, ethical concerns, such as data privacy and system security, are significant barriers to adopting telehealth and in-home monitoring technologies [35].

The adoption of assistive technologies is often hindered by a lack of user competence, as well as ethical and knowledge-related barriers [61]. To address these challenges, policymakers must ensure personalised training, engage relevant stakeholders, and design technologies that are culturally relevant and easy to use [7].

Technological Limitations and Usability Challenges

The adoption of gerontechnology, such as smart home systems and social robots, shows promise in enhancing daily living and reducing caregiver stress. However, usability issues, system complexity, and privacy concerns remain significant barriers [3]. Older adults often find it difficult to use new technologies, which can lead to increased stress and dissatisfaction [45]. Even technologies like virtual assistants, which bypass physical limitations, face adoption challenges due to low digital literacy and poor system design for users with motor and sensory impairments [46,76].

Implementation Barriers in Gerontechnology

Implementing gerontechnology faces further barriers, such as ethical concerns, high costs, and technical issues [10,7]. There is often a mismatch between the capabilities of older adults and the technologies designed for them, which limits the effectiveness of these interventions [31]. Moreover, the absence of standardised outcome measures and the variability in assessment tools across studies make it difficult to evaluate the effectiveness of these technologies consistently. This lack of longitudinal studies also limits our understanding of the long-term benefits and sustainability of gerontechnology interventions [51].

Research Limitations and Study Quality

One of the most significant limitations in the current body of research is the inconsistent quality of the included studies. Some studies demonstrated rigorous methodologies, but others lacked sufficient detail in reporting or applied less robust designs. This variability in study quality, combined with differences in the types of technologies assessed, populations targeted, and contexts in which interventions were implemented, complicates the ability to generalise findings [69,52].

Furthermore, the absence of standardised outcome measures across studies and the diversity of tools used to assess interventions' impact hampers the synthesis and comparison of findings. These limitations make it challenging to aggregate results effectively and gain insight into the sustainability and long-term benefits of gerontechnology interventions [16].

Social Isolation and Health Disparities

Older adults remain vulnerable to social isolation, which poses significant health risks. While technologies like virtual health assistants (VHAs) and peer training have proven effective in reducing loneliness, barriers such as privacy concerns, lack of access, and technological difficulties persist [50,13]. Moreover, challenges related to housing affordability, insecurity of tenure, and accessibility exacerbate health disparities in ageing populations [43].

Conclusion

In conclusion, while gerontechnology offers considerable potential to support older adults and their caregivers, significant barriers remain regarding usability, privacy, and cost. The inconsistent quality of studies, lack of standardised outcome measures, and absence of longitudinal research further limit the ability to fully understand the long-term benefits of these interventions. To optimise the adoption and impact of gerontechnology, policymakers must prioritise training, improve accessibility, and encourage the development of culturally relevant, user-friendly technologies. Rigorous, standardised, and long-term research will be

essential to overcoming these limitations and maximising the benefits for ageing populations.

Discussion

Summary of Discussion

The World Health Organisation (WHO) and the United Nations define an “ageing society” as one in which more than 7% of the population is 65 years or older, an “aged society” as a society in which more than 14% of the population is 65 years or older, and a “super-aged society” as a society in which more than 21% of the population is 65 years or older. Since 2013, Japan has been a super-aged society in which more than 25% of the population is 65 years or older. In other words, 1 in 4 persons in the Japanese population is elderly and the elderly population of Japan is forecast to continue to grow in the future [4].

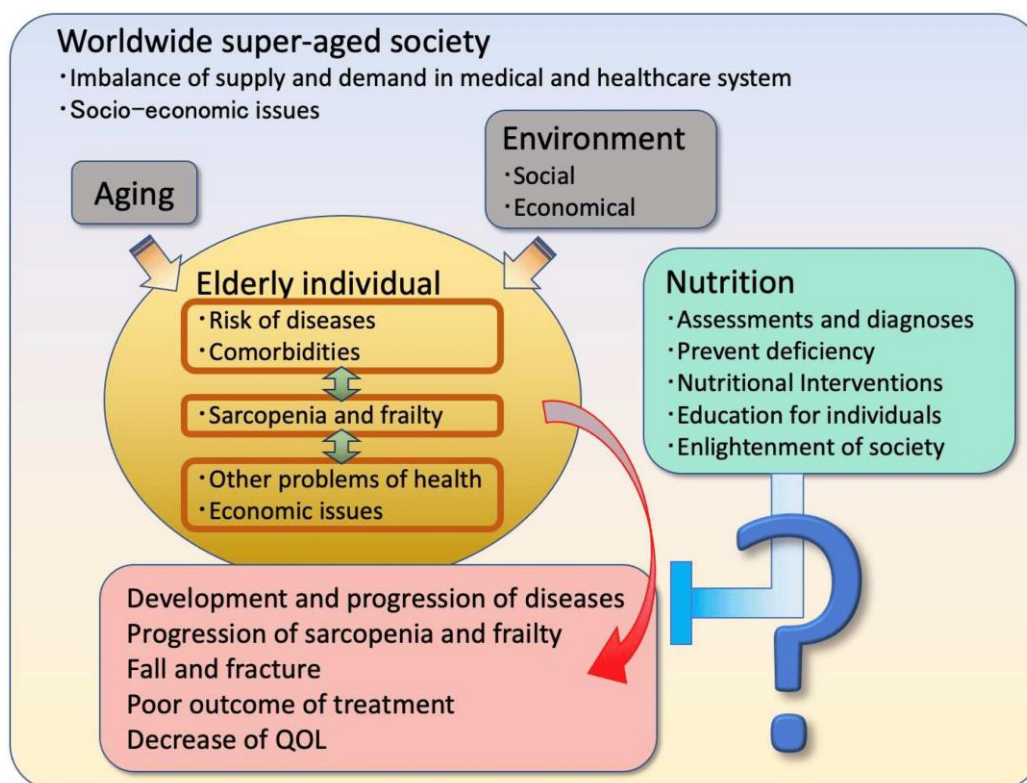


Figure 2: Worldwide Super-Aged Society [77].

Source: (Yoshida et al, 2023)

Figure 2 provides a visual roadmap and is important to understand how proper nutrition can potentially reduce the negative health outcomes that are prevalent in a super-aged society. In such societies, conditions like sarcopenia (muscle loss), frailty, and related comorbidities (such as diabetes, chronic kidney disease, heart failure, and dementia) become increasingly common. Figure 2 also shows how these issues can be addressed through nutrition, emphasising the prevention and management of diseases associated with ageing [77].

In terms of gerontechnology, the table below highlights technology that can be used to support the wellbeing of older adults.

Table 1. Technologies Used to Support the Wellbeing of Older Adults: Purpose and Examples [31]

| Purpose of technology | Examples of technologies |
|--|---|
| 1. Technology for safety and security: provides safe home environments. Provides social contact and participation to prevent loneliness. May contribute to individuals living at home for a longer period of time. | Safety alarms, stove timer, door sensor alarm, bed sensor alarm, GPS (localisation technology), fall indicator, camera solutions, electronic door-locks, verbal reminders if an unwanted situation occurs, e.g. leaving the house at night. Video-communication |
| 2. Health surveillance technologies (for assessments and treatments at home). | Safety monitoring. Advanced medical equipment used for assessments and treatments in the patient’s home, e.g. check-ups for COPD patients. Applications for monitoring and self-reporting of health status |
| 3. Technologies for wellbeing: to build awareness about own health and prevent ill health. | Wearables to monitor conditions of the body: training clock, pulse meter, activity wristband, log sleep patterns, etc. Robot vacuum cleaner, robot lawnmower, smart-home solutions and communication technology for social contact and interaction. |
| 4. Technologies for coping with everyday living and managing health-related problems. Technologies for patients with chronic and/or psychiatric illness and those within rehabilitation programs. | Simple-to-use mobile phones (large screens and number pad), simple TV remote control, electronic medicine dispensers, digital calendar with activity plan and reminders, digital games such as Wii, Xbox, etc. |

The findings of the literature review that address each of the research objectives and questions originally posed are presented below. The research objective is identified, and the table presented below it highlights the literature response using the research questions to guide the information presented. A summary of the information in each table is presented prior to each table.

Research Objective 1: Identify Existing Telehealth and Ageing in Place Initiatives

Table 2: A Summary of Assistive Technologies and Interventions showcases initiatives the scoping review identified as being designed to enhance the lives of older adults, particularly those with dementia. The research question addressed in this section is, what are the current telehealth and ageing in place initiatives available in Aotearoa that are specifically designed or adaptable for Kaumātua, particularly those focusing on dementia and loneliness? Key findings reveal that these technologies, such as adapted training, ICT-based cognitive interventions, mobile apps, virtual home assistants, and remote monitoring, effectively improve cognitive function, social connectedness, quality of life, and medication adherence.

These interventions support independence and well-being by addressing specific needs and promoting engagement, safety, and health monitoring.

However, there are significant barriers that must be addressed if widespread adoption of these technologies is to happen, including technology anxiety, privacy concerns, system failures, and the digital divide. To overcome these challenges, co-designing adaptable solutions, expanding digital literacy programs, enhancing stakeholder involvement, and investing in further research to establish efficacy and guide implementation is recommended. By addressing these barriers and focusing on user-centred design, these technologies can better support older adults with dementia.

Table 2. A Summary of Assistive Technologies and Interventions

| Key Findings | Effectiveness/Promotors | Barriers | Recommendations | References |
|--|---|--|---|----------------------|
| Assistive Technology and Telecare (ATT) | Personalised training, safety, stakeholder involvement, ease of use, cultural relevance | Unintended adverse consequences, timing, technology anxiety, system failures, digital divide | Focus on co-design and adaptability of ATT solutions, enhancing stakeholder involvement, tailoring solutions to the disease context | Boyle et al., 2022 |
| ICT-based Cognitive Interventions | Improved cognitive function and reduced depression in older adults with MCI or mild dementia | | Expand ICT-based cognitive training, with nurses playing a pivotal role in facilitating interventions | Chae & Lee, 2023 |
| Mobile App-based Interventions | Serious games, recall therapy, musical mobile apps improved cognitive abilities and independent living for people with dementia | | Encourage development and use of mobile app-based interventions focusing on cognitive enhancement and independent living | Cheng et al, 2024 |
| Voice-activated Virtual Home Assistants (VHA) | Improved social connectedness and reduced loneliness among older adults | Privacy and ethical concerns | Promote VHAs for social connectedness while addressing privacy concerns and providing structured training | Corbett et al., 2021 |

| | | | | |
|---|--|-----------------------------------|--|---|
| Medication Adherence via Telehealth | Improved medication adherence in older patients with dementia | | Develop and implement interventions to improve medication adherence | El-Saifi et al., 2018 |
| Assistive Technologies for Dementia Care | Social robots, electronic medication dispensers, trackers, motion detectors improved quality of life, social interaction, and reduced caregiver stress | | Invest in research and development of cost-effective socially assistive robots and other assistive technologies | Ghafurian et al., 2021; Sriram et al., 2019 |
| Remote Monitoring Technologies | Diverse and innovative use in supporting ageing in place | More high-quality research needed | Promote further research to provide robust evidence for efficacy and guide implementation | Read et al., 2023 |
| Digital Assistive Technologies (DATs) | Support autonomy, engagement, social interaction, health monitoring, and safety for people with dementia, improving quality of life | | Support the development and integration of diverse DATs to enhance the quality of life for people with dementia, focusing on underrepresented digital health technology categories | Schneider et al., 2024 |
| Living Labs for Dementia | Optimising health, quality of life, independent living, home care, and safety for older adults with dementia | | Support better-quality interventional research in living labs to prove the effectiveness of their innovations | Verloo et al., 2021 |

| | | | | |
|--|---|---------------------------------------|--|---------------------|
| Smartphones and Tablets as Cognitive Aids | Support cognitive function and memory | Digital literacy and usability issues | Enhance digital literacy programs and design inclusive technology that accommodates motor and sensory impairments | Wilson et al., 2022 |
| Socially Assistive Robots | Feasible and acceptable but no clear benefit for cognition or neuropsychiatric symptoms | | Invest in high-quality research to establish the effectiveness of socially assistive robots and address usability issues | Yu et al., 2022 |

Research Objective 2: Evaluate Accessibility and Usability for Kaumātua

Table 3: Accessibility and Usability of Gerontechnology Initiatives summarises key findings and the research question addressed in this section is, how accessible and user-friendly are these initiatives for Kaumātua, considering cultural appropriateness, technological literacy, and other potential barriers?

The table shows that while many technologies, such as Assistive Technology, ICT-based cognitive interventions, and digital assistive tools, can significantly enhance the independence, safety, and cognitive health of older adults, accessibility remains a challenge due to factors like the digital divide, privacy concerns, and technical difficulties.

Usability tends to improve when the technologies are co-designed with users, personalised, and when adequate training is provided. Recommendations emphasise the need for community involvement in designing solutions, creating clear implementation frameworks, and ensuring ongoing support to make these technologies more effective and inclusive for Kaumātua.

Table 3. Accessibility and Usability of Gerontechnology Initiatives

| Gerontechnology Initiative | Accessibility | Usability | Recommendations | Study |
|--|--|---|--|-----------------------|
| Assistive Technology & Telecare | Mixed accessibility across populations due to digital divide and system failures | High usability when personalised and involving all stakeholders | Co-design with communities, clear implementation strategies, continuous evaluation and training | Boyle et al. (2022) |
| ICT-based Cognitive Interventions | Broad accessibility through community-based applications | Effective for cognitive improvement, but requires tailored implementation | Expand ICT training for community-dwelling older adults, nurses pivotal in facilitating interventions | Chae & Lee (2023) |
| Voice-Activated Virtual Home Assistants | Accessible, though concerns about privacy and costs | High usability, reduces loneliness, but some ethical and privacy issues | Regulatory framework needed for privacy, focus on age-friendly design, provide training for older adults | Corbett et al. (2021) |

| | | | | |
|---|--|---|--|-------------------------|
| eHomecare, Sensor Systems | Accessibility varies due to user difficulties and technical issues | Increased safety and caregiver support, but dissatisfaction among older users | Co-construction with communities, improve ease of use, ensure alignment with users' needs and privacy concerns | Moreno et al. (2023) |
| Digital Assistive Technologies (DAT) | Generally accessible but dependent on technological infrastructure | Supports autonomy, engagement, and safety, but requires ongoing user support | Focus on developing diverse and inclusive DATs, ensure continuous training and policy support | Schneider et al. (2024) |

Research Objective 3: Analyse the Impact on Kaumātua Well-Being Using Existing Qualitative and Quantitative Data

Table 4: The Impact on Kaumatua Well-Being and the Data Sources used, addresses two research questions,

- i. What evidence exists regarding the impact of these initiatives on the well-being of Kaumātua, especially in terms of managing dementia symptoms and reducing feelings of loneliness?
- ii. What are the key challenges and limitations faced by current gerontechnology initiatives in reaching and effectively supporting Kaumātua?

The table below in summary highlights the positive impact of various gerontechnology interventions on areas like cognitive function, social connectedness, safety, and caregiver support. It also shows that Assistive Technology and Telecare (ATT) and ICT-based cognitive interventions improved cognitive and psychological outcomes for Kaumātua, while Voice-Activated Virtual Home Assistants (VHA) reduced loneliness.

The evidence used to support these findings includes both qualitative data, such as interviews and feedback from users and caregivers, and quantitative data from systematic reviews and meta-analyses of multiple studies. This combination of qualitative insights and sound quantitative analysis provides a solid foundation for understanding the benefits and challenges of these technologies for Kaumātua.

Table 4: The Impact on Kaumatua Well-Being and The Data Sources Used

| Intervention | Impact on Well-Being | Qualitative Data Used | Quantitative Data Used | Study |
|--|--|--|--|-------------------------|
| Assistive Technology & Telecare (ATT) | Improved safety and stakeholder involvement; barriers include system failures and technology anxiety | Interviews with stakeholders (caregivers, healthcare professionals) regarding experiences with ATT | Data from 30 studies using PRISMA guidelines (systematic review) | Boyle et al. (2022) |
| ICT-based Cognitive Interventions | Significant improvement in cognitive function and reduction in depression | Interviews with community-dwelling older adults about their cognitive changes | Meta-analysis of 44 studies measuring cognitive and psychological outcomes | Chae & Lee (2023) |
| Voice-Activated Virtual Home Assistants (VHA) | Reduced loneliness and improved social connectedness; privacy concerns identified | User feedback from older adults on social isolation and loneliness | Mini-review of 7 studies examining VHA use in older adults | Corbett et al. (2021) |
| e-Health Solutions | Positive effects on cognitive functioning and psychological well-being; improved caregiver self-efficacy | Observations and interviews with caregivers and older adults using e-health platforms | Systematic review of 72 studies focusing on e-health interventions | Dequanter et al. (2021) |
| Gerontechnologies for Ageing in Place | Increased safety, reduced caregiver stress, improved communication and daily living | Feedback from older adults and caregivers on ease of use and challenges | Systematic review of 13 studies, including data on monitoring and communication technologies | Moreno et al. (2023) |

Research Objective 4. Provide recommendations to inform practice, policy and future actions and research

Table 5: Recommendations to Inform Practice, Policy, Future Actions addresses the following research question, what are the recommendations that can be made to improve the access, design, implementation, and adoption of gerontechnology solutions for Kaumātua?

The table highlights key recommendations from the 30 studies included within this scoping review on gerontechnology interventions aimed at improving the well-being of older adults, particularly in areas such as cognitive support, social isolation, and independent living. The studies recommend integrating assistive technologies, smart home modifications, telemedicine, and socially assistive robots into care practices to enhance safety, independence, and social interaction.

There is a strong emphasis on co-designing these solutions with end-users and stakeholders to ensure cultural relevance and ease of use.

For policy, the recommendations include the need for frameworks that ensure affordability, accessibility, and the ethical use of technologies.

Research priorities focus on long-term impact assessments, cost-effectiveness studies, and addressing gaps in current knowledge, particularly regarding the social and psychological effects of these interventions.

The next steps call for the development of training programs, further collaboration across sectors, and international engagement to accelerate the growth of gerontechnology in New Zealand.

Table 5: Recommendations to Inform Practice, Policy, Future Actions and Research

| Study | Recommendations for Practice | Recommendations for Policy | Recommendations for Research | Recommendations for Next Steps |
|--------------------------------|--|---|---|--|
| Boyle et al. (2022) | Provide personalised training and support for ATT users | Co-design ATT solutions with all stakeholders and ensure cultural relevance | Investigate long-term effects of ATT adoption on well-being | Develop pre-implementation and continuous evaluation strategies |
| Chae & Lee (2023) | Expand ICT-based cognitive interventions in communities | Integrate nurses as key facilitators of ICT interventions | Research diverse cognitive intervention methods | Create training programs for caregivers and healthcare professionals |
| Cheng et al. (2024) | Encourage the use of mobile app-based interventions for independent living | Implement guidelines for using mobile apps for cognitive enhancement | Study the effectiveness of different app types | Develop mobile apps focused on enhancing cognitive abilities for older adults |
| Corbett et al. (2021) | Use voice-activated virtual assistants to reduce loneliness | Create regulatory and ethical frameworks for VHA use | Explore the long-term social and psychological effects of VHA | Provide training on the effective use of VHAs |
| Dequanter et al. (2021) | Utilise e-health solutions for cognitive and behavioral health | Ensure e-health technologies are accessible and affordable | Research the cost-effectiveness of e-health solutions | Train caregivers and older adults on how to use e-health platforms |
| El-Saifi et al. (2018) | Implement medication adherence interventions through technology | Improve caregiver support systems for medication adherence | Research interventions improving medication adherence in dementia care | Leverage gerontechnology aids (e.g., reminders, dispensers) for better adherence |
| Gan et al. (2024) | Foster inclusive community environments that promote cognitive health | Ensure technologies are accessible and affordable | Research community-level interventions for cognitive decline prevention | Provide continuous training for caregivers and users in dementia care settings |

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| Ganesan et al. (2019) | Promote ambient assisted living technologies to enhance independence | Develop policies to support safe, sustainable living environments | Investigate the effects of smart home technologies on cognitive health | Lead development and promotion of technologies for ageing populations |
| Gettel et al. (2021) | Increase public awareness of dementia care technologies | Address privacy concerns in dementia care tech deployments | Study the user experience and privacy issues in fall detection technologies | Develop strategies to overcome user experience challenges in tech adoption |
| Ghafurian et al. (2021) | Use socially assistive robots to improve quality of life | Invest in the development of cost-effective assistive robots | Research the effectiveness of robots in dementia care | Address usability issues and provide adequate training for caregivers |
| Gorenko et al. (2021) | Implement remote interventions to reduce loneliness during pandemics | Develop funding for remote programs tailored to older adults | Research the long-term impact of remote interventions on psychological health | Provide digital support and ensure accessibility for older adults |
| Gunnes et al. (2024) | Promote ICT-based solutions to mitigate social isolation | Broaden access to ICT and ensure user-friendly designs | Research the impact of ICT on loneliness in different environments | Provide education on ICT use for older adults and caregivers |
| He et al. (2023) | Adopt non-pharmacological interventions for sleep disturbances in dementia care | Develop guidelines for integrating light therapy and robotic pets in dementia care | Study the effectiveness of various non-pharmacological interventions | Train caregivers on non-pharmacological interventions for sleep disturbances |
| Hill et al. (2024) | Improve telecaregiving tools and interventions for dementia care | Support policy development for remote caregiving solutions | Study the needs and experiences of telecaregivers in different settings | Invest in the development of telecaregiving technologies and support systems |
| Hirt et al. (2021) | Use social robots like PARO to reduce stress and apathy | Invest in policies supporting the use of social robots in care facilities | Further research on the impact of social robots on behavior and cognition | Provide training and support for caregivers on how to use social robots effectively |

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|----------------------------------|---|--|---|---|
| Khan et al. (2023) | Implement sensor-based assessments to monitor social isolation | Create guidelines on privacy and ethical use of sensor technologies | Study the accuracy and effectiveness of sensor-based assessments | Educate caregivers and healthcare professionals on the use of sensor technology |
| Kim et al. (2022) | Promote smart home technologies for ageing in place | Support integration of smart technologies into senior housing developments | Research the impact of smart homes on independent living | Ensure user-friendly and affordable smart technologies for ageing adults |
| Ma et al. (2022) | Use smart home modifications to enhance independent living | Support policies promoting universal design for smart homes | Investigate the integration of smart technology in home modifications | Provide training for architects and caregivers on smart home design |
| Moreno et al. (2023) | Ensure gerontechnology matches users' needs and abilities | Co-construct solutions with communities and technical experts | Research the cost-effectiveness of gerontechnology | Provide training for caregivers and older adults on gerontechnology use |
| Moret-Tatay et al. (2021) | Use virtual assistants for cognitive assessment | Support policy development for virtual assistants in cognitive health | Research the effectiveness of virtual assistants for cognitive assessment | Provide user-friendly virtual assistants for older adults |
| Nkodo et al. (2022) | Use telemedicine to manage dementia symptoms in remote areas | Expand telemedicine services for dementia care | Study the long-term effects of telemedicine on dementia care | Focus on increasing access to telemedicine in underserved areas |
| Phang et al. (2023) | Implement digital intergenerational programs to reduce social isolation | Support funding and policy for intergenerational programs | Research the effectiveness of digital intergenerational programs | Develop tailored programs based on older adults' characteristics |
| Piau et al. (2019) | Use digital biomarkers for monitoring cognitive function | Develop standards for the use of digital biomarkers | Research privacy and ethical concerns related to digital biomarkers | Promote the development of user-friendly digital biomarkers |

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|--------------------------------|---|--|---|---|
| Rashid et al. (2023) | Use PARO robots to reduce medication use and anxiety | Promote non-pharmacological interventions like PARO in care settings | Conduct more rigorous research with larger sample sizes on PARO | Ensure adequate training for caregivers using therapeutic robots |
| Read et al. (2023) | Use passive remote monitoring to improve safety and security | Develop policies ensuring the ethical use of monitoring technologies | Research the effectiveness of passive monitoring technologies | Promote user-friendly designs and provide support for older adults |
| Schneider et al. (2024) | Use digital assistive technologies to improve autonomy and social interaction | Support policy promoting the use of diverse digital assistive technologies | Research the impact of digital assistive technologies on quality of life | Train caregivers and users on the use of assistive technologies |
| Sriram et al. (2019) | Use assistive technology to support informal caregivers in dementia care | Develop a system for classifying assistive technology devices | Research the family-centered model of assistive technology | Provide support and training for informal caregivers on technology use |
| Verloo et al. (2021) | Use living labs to test innovations for dementia care | Support the creation of living labs to optimise dementia care | Research the effectiveness of innovations developed in living labs | Foster collaboration between healthcare providers and living labs |
| Wilson et al. (2022) | Use smartphones and tablets to aid memory and cognition | Develop policies to enhance digital literacy programs for older adults | Research the impact of mobile technology on cognitive health | Provide inclusive digital literacy training tailored to older adults |
| Yu et al. (2022) | Use socially assistive robots to improve social interaction | Invest in policies supporting the use of assistive robots in care | Research the effectiveness of assistive robots in improving quality of life | Provide training on the use of socially assistive robots for caregivers |

Limitations of this review

The limitations of this scoping review include several factors including a very limited evidence base, with only 30 studies finally included. Variations in study design, methodologies, and intervention types make it challenging to synthesise findings cohesively. Additionally, the geographical distribution of the studies included primarily reflects research conducted in developed countries.

The variability in outcome measures across studies is another limitation. Different studies utilised varied metrics to assess the effectiveness of gerontechnology interventions, complicating the comparison and synthesis of results. Furthermore, many studies included in the review had small sample sizes and short follow-up periods, limiting the ability to draw long-term conclusions about the interventions' sustainability and overall impact. In addition, there was also an absence of cost-effectiveness or cost-benefit analysis within the studies included that may have provided important insights for recommendations.

Another limitation is the reliance on published literature, which may introduce publication bias. Studies with positive outcomes are much more likely to be published, potentially skewing the review's findings. Moreover, the review's scope has excluded relevant grey literature, such as unpublished studies, reports, and conference papers, which could provide additional insights into the efficacy and challenges of gerontechnology interventions.

Recommendations

Implications for New Zealand

As New Zealand faces the challenges of an ageing population, it is crucial to prioritise the integration of gerontechnology into health and social care systems. This section outlines key recommendations and implications for policymakers, focusing on the unique needs of older adults experiencing the worst outcomes across the health spectrum, notably Māori and Pacific peoples. Addressing health disparities for those worst off will enhance the health system for everyone, hence a focus on Māori and Pacific peoples, should guide the development of all gerontechnology interventions. The development of age-friendly environments, culturally centred health solutions, and accessible technologies such as telehealth, remote monitoring systems, and social robots can improve quality of life and support independent living for older adults.

Policymakers must also ensure that digital literacy and financial accessibility are prioritised, with a focus on training and stakeholder involvement to support the adoption of these technologies. By learning from international examples and aligning with global best practices, New Zealand can create a more sustainable and equitable healthcare system for its ageing population.

Addressing Health Disparities

To improve health outcomes for all New Zealanders, particularly groups such as Māori, there is a strong need to address health disparities [43]. This focus on equity should guide all gerontechnology interventions and related policies, ensuring that healthcare solutions are accessible to all.

Age-Friendly Environments

Creating age-friendly environments is crucial to reducing inequalities and improving the health and wellbeing of older people [74]. In New Zealand, the Office for Seniors has provided leadership in the progression of this movement, but an inter-agency approach is required to support faster development including integrating age-friendly principles into urban planning, housing, and technology design to help ensure that older adults can live independently and healthily for longer.

Culturally Centred Interventions

Culturally relevant interventions are essential for improving social and health outcomes. Tailoring gerontechnology and health programs to the cultural contexts of Māori and Pacific peoples in New Zealand will ensure higher engagement and effectiveness [56]. This approach can significantly contribute to a sense of purpose, identity, and better health outcomes.

Barriers to Adoption of Assistive Technologies

One significant barrier to the adoption of assistive technologies is cost, with affordability limiting access for many older adults [23]. Addressing this barrier is best through policymakers prioritising financial support mechanisms and leveraging relationships with key stakeholders to ensure equitable access to these technologies across all populations.

Dementia/Mate Wareware Action Plan

The Dementia/Mate Wareware Action Plan aims to improve the health, independence, and quality of life for New Zealanders living with dementia. Supporting gerontechnology initiatives that align with this plan will ensure that older adults with dementia and their caregivers can access the latest technologies to support their care [44].

Health and Autonomy

Older adults' perceived autonomy and understanding of tikanga have been positively correlated with better self-rated health [49]. Promoting policies that enhance autonomy and provide culturally relevant care and housing solutions is essential for improving the quality of life for older adults.

Implementing Welfare Technology

The successful implementation of welfare technology is vital to delivering personalised, "person-fit" solutions that enhance older adults' independence and provide socio-economic benefits [31]. These technologies should be tailored to individual needs and reduce the reliance on external support systems.

Design Considerations for Smart Home Technologies

The implementation of smart home technologies must address privacy concerns and be integrated into home design during early stages to ensure comfort and acceptance [35]. Designing systems that prioritise user autonomy and data security will help foster trust in these technologies.

Integration and Minimal Interference in Smart Homes

Smart home modifications should balance the integration of new technologies with existing housing structures, while also respecting older adults' preference for minimal interference [39]. This will ensure that older adults can remain in their homes safely and comfortably.

Feasibility and Acceptance of Telemedicine

Telemedicine interventions for older adults, particularly those with behavioural and psychological symptoms of dementia (BPSD), have been found to be feasible and well-accepted [48]. Expanding telemedicine services in New Zealand could reduce caregiver burden and provide critical support to older adults.

Telehealth and Mental Health Interventions

Telehealth has proven effective in delivering psychological interventions, such as cognitive behavioral therapy (CBT), and in reducing symptoms of anxiety and depression in older adults [25]. Expanding access to telehealth mental health services is crucial to improving the psychological wellbeing of ageing populations.

Telehealth Monitoring Systems

Remote health monitoring systems allow caregivers to intervene more promptly, improving health outcomes for older adults and reducing caregiver burden [10]. Policymakers should support these systems to enhance healthcare delivery and facilitate real-time health monitoring.

Social Inclusion and Cognitive Health

Social inclusion and access to community resources are critical for maintaining cognitive health in older adults [19]. Policymakers are well placed to prioritise programs that encourage social engagement and offer access to local resources to help older adults stay mentally and socially active.

Social Robots and Companionship

Social robots can improve social interaction and assist older adults in managing their daily health routines, reducing loneliness [3]. Incorporating these robots into care plans can support the mental health and wellbeing of older adults.

Training as a Facilitator for ICT Use

Training courses have been identified as crucial for improving technological competence among older adults, reducing loneliness, and increasing engagement with health technologies [26]. Investing in digital literacy training will empower older adults to use ICT effectively and benefit from health innovations. Targeting delivery of such training within natural gathering places for older adults provides social connectivity, familiar spaces and faces along with the educational experience.

Importance of Stakeholder Involvement

Stakeholder involvement is key to the successful adoption of gerontechnologies. Older adults using virtual health assistants (VHAs) have expressed the need for structured training on how to use these devices [13]. Involving caregivers, healthcare professionals, and users themselves in the development and deployment of these technologies will ensure that they are user-friendly and widely adopted.

Improving Digital Literacy for Older Adults

The COVID-19 pandemic highlighted the importance of improving digital literacy among older adults so they can fully benefit from assistive technologies [22]. Future health policies should prioritise training programs to improve older adults' technological skills and reduce social isolation.

International Recognition of Gerontechnology Research

New Zealand can develop its understanding and implementation of gerontechnology quickly by looking to international examples, such as Monash University Malaysia's Gerontechnology Lab, which is recognised for its global leadership in ageing innovations [64]. By collaborating internationally, New Zealand can also accelerate its innovation capacity, improve its preparedness for a super-aged society and potentially position itself as a future leader in ageing solutions.

International Experiences of An Ageing Population

There is a direct link between age and the demand for healthcare [23]. As Singaporeans continue to age rapidly, more bold and innovative policy reforms as well as financing options of healthcare will be among the top priorities on the healthcare reform agenda. The supply-side options can include better use of technology, better information sharing on diagnosis, treatment options, and even outsourcing to neighbouring countries like Thailand and Malaysia [23]. Ageing and population growth both contribute to the rise in health care

demand, and costs [42]. In any year per capita health spending for people aged sixty-five or older tends to average three to five times that for younger Americans [52]. However, a rise in health care costs can also be attributed to advances in medical technology needed to support an ageing population. Diagnostic and therapeutic advances, such as new radiological scanners, biological therapeutics and prostheses, often come at a considerable cost [6].

Policy and Recommendations

A generalised policy approach to gerontechnology may not be effective, as older adults and caregivers represent heterogeneous groups with distinct needs [32]. In addition, information technologies have the potential to affect the types and distribution of jobs in the health workforce, modifying the traditional roles of provider and patient and providing opportunities for new kinds of employment in health-related professions [41]. Retiring at a later age may lessen or postpone poor health outcomes for older adults, raise well-being, and reduce the utilisation of health care services, particularly acute care [16]. Tailored policies that consider these factors will lead to better adoption and more effective outcomes for New Zealand's ageing population.

Conclusion

To improve health outcomes for New Zealand's ageing population, especially for groups such as Māori, a multifaceted approach is required. Addressing health disparities, fostering age-friendly environments, research, and innovation, and ensuring affordability are crucial steps to facilitate the widespread adoption of gerontechnology. Key areas of focus include enhancing digital literacy, promoting culturally relevant interventions, and integrating smart home technologies with minimal interference in daily life.

Telehealth services have proven to be effective in addressing both physical and mental health challenges, while remote health monitoring systems and social robots offer significant potential for reducing caregiver burden and improving social interaction. However, it is essential to address privacy concerns, involve stakeholders in the technology design process, and ensure that training is provided to older adults to enhance the usability and adoption of these technologies.

By aligning with international best practices, collaborating with countries already investing in gerontechnology and recognising the unique needs of diverse populations, New Zealand can develop capacity and capabilities quickly at a lower cost whilst also growing innovation with an aim to build our leadership in the field of gerontechnology and more importantly our preparedness for an ageing population. Tailored policies, person-centred solutions, and investments in welfare technology will empower older adults to live independently, improve their quality of life, and contribute to the sustainability of our healthcare system.

Next steps including areas for future research

With advancing gerontechnology in mind to better support Kaumātua and improve health outcomes, this section outlines key recommendations and research priorities for policymakers. Focus areas include addressing chronic condition management through telemonitoring, enhancing the role of telemedicine and caregiver resources, and improving

data collection for healthy ageing. Future research should prioritise culturally relevant, user-friendly solutions, particularly for Māori and Pacific communities, while overcoming technical limitations, and improving long-term usability of assistive technologies. Building on current investments in gerontechnology—such as the living lab at the University of Auckland, robotics research by Professor Bruce MacDonald, and brain health technology research at the University of Otago—will position New Zealand as a leader in gerontechnology. Engaging international expertise, fostering collaborations across sectors, and learning from global innovations will ensure a sustainable health system for the benefit of Kaumātua, whānau caregivers, and the health workforce.

Chronic Condition Management

Telemonitoring technologies have shown great potential in managing chronic conditions such as hypertension and COPD. However, further research is needed to assess their long-term effectiveness and sustainability in improving health outcomes for older adults [36]. Expanding the use of telemonitoring within the healthcare system could provide significant support to older adults living with chronic conditions, reducing the burden on healthcare facilities.

Telemedicine and Caregiver Resources During the COVID-19 Pandemic

During the COVID-19 pandemic, digital health technologies, including telemedicine and caregiver resources, were critical in addressing social isolation and providing access to care [8]. Building on these lessons will help policymakers develop resilient healthcare systems for future emergencies and expand telehealth services for older adults.

Data Collection and Research

A key priority for policymakers is improving global data collection on healthy ageing. This is currently lacking in many regions and limits the ability to accurately assess the effectiveness of gerontechnologies on a global scale [74]. Focusing on collecting more comprehensive data in New Zealand will help build a robust evidence base for the development and adoption of gerontechnology solutions.

Improving Living Lab Studies

Living lab studies offer valuable insights into real-world applications of gerontechnology. However, there is a need for more interventional research to improve their quality and scope [69]. This will help policymakers assess the long-term viability of these technologies and their impact on the health and wellbeing of older adults. One is currently in development at the University of Auckland and led by Professor Ngaire Kerse.

Future Directions for Assistive Robot Research

As assistive robots evolve, future research should aim to improve their cognitive and emotional capabilities to better support people with dementia and their caregivers [24]. Enhancing robot functions could significantly reduce the caregiver burden and improve the quality of life for those with dementia, which is critical as New Zealand faces an ageing population.

Usability and Acceptance of Virtual Assistants

Virtual assistants have the potential to support older adults in managing their health, but more research is needed on their usability and acceptance to ensure that they can benefit from these advancements [46]. Understanding barriers to adoption will help inform the design of more user-friendly solutions.

Targeting Social Connectedness

Future research should focus on developing targeted digital programs that enhance social connectedness for older adults, particularly in combating loneliness [50]. In New Zealand, increasing social interaction through technology will be a critical component in improving mental health outcomes for the elderly.

Refining Outcome Measures and Addressing Gender Differences

Future research should prioritise the refinement of outcome measures, addressing gender differences, and improving the usability of ICT interventions [26]. These measures will help ensure that digital solutions meet the specific needs of diverse user groups, improving health outcomes and technology adoption.

Predictive Models for Social Isolation

Developing predictive models using data from sensor technologies could significantly improve the assessment and detection of social isolation among older adults, enabling earlier interventions [34]. This will be key to supporting social connectedness and mental health in ageing populations, especially in rural and isolated communities in New Zealand.

Family/Carer-Centred Research Models

To better support caregivers, future research into assistive technologies should incorporate family/carers-centred models [61]. Ensuring that both the needs of caregivers and care recipients are considered will lead to better outcomes for both groups, particularly in the context of dementia care.

Personhood and Cultural Engagement

Promoting inclusive care environments that focus on personhood and cultural engagement can mitigate the negative effects of cognitive decline [19]. In New Zealand, culturally relevant interventions will be critical to ensuring gerontechnology is accessible and effective for Māori and Pacific peoples. This focus will also help ensure higher engagement and better health outcomes.

Larger Sample Sizes for Paro Research

Larger-scale studies are needed to better understand the mechanisms and effectiveness of Paro robots in supporting older adults with dementia [52]. Expanding research into these non-pharmacological interventions will help identify best practices for dementia care in New Zealand.

Overcoming Technical Limitations and Long-Term Usability

To ensure long-term success, research should also focus on overcoming technical limitations and ensuring the usability of gerontechnologies across diverse home environments [51]. This

will be key to maximising the accessibility and impact of these technologies across New Zealand's urban and rural settings.

Smart Technology for Cognitive Support

Further research is required into the use of smartphones and tablets as *tools* for cognitive support, especially in the early stages of cognitive decline [76]. Developing effective digital memory aids will be essential in helping older adults maintain cognitive health and independence.

Involving End Users in Co-Creation

It is critical that future research includes the *values* and preferences of end users in the design and development of technologies. Co-creation and easy-to-use designs will help ensure acceptability and wide dissemination of gerontechnology solutions [45]. Engaging older adults in the design process will foster better adoption and user satisfaction.

Combining Non-Pharmacological Measures for Sleep Interventions

Further research is also needed to explore the combination of non-pharmacological measures for managing sleep disturbances in people living with dementia (PLWD) [28]. This could offer more holistic approaches to improving sleep quality and overall health in older adults, reducing reliance on medication.

Exploring Underrepresented Health Technologies

There is a need for more research into underrepresented digital health technologies, particularly in the areas of care support and wellness software [55]. These categories could play a significant role in preventive health strategies and enhancing the overall wellbeing of older adults.

Need for More High-Quality Research

High-quality research is essential for understanding the full impact of gerontechnologies on older adults and their caregivers. Existing studies often have limitations in scope and scale, and more rigorous studies are required to fully assess their effectiveness [53]. Larger sample sizes and longer follow-up periods will be needed to draw conclusive results and inform policy decisions. This requires a long-term approach to the investment in research and innovation and the creation of a platform that supports the collaborative relationships needed to co-design, develop and trial needed gerontechnologies.

Conclusion

To advance gerontechnology for Kaumātua, New Zealand must leverage current expertise and developments as well as prioritise culturally relevant, user-friendly innovations. A focus on refining outcome measures, improving usability, and addressing the unique needs of Māori and Pacific communities is essential. Engaging Kaumātua in the co-creation of technologies will foster greater adoption. The investment in gerontechnology has already begun, with initiatives like the living lab at the University of Auckland, led by Professor Ngaire Kerse, research on robotics by Professor Bruce MacDonald, and studies on brain health and technology at the University of Otago led by Professor John Reynolds and Associate Professor Louise Parr-Brownlie.

To maximise these efforts, conducting a stocktake of current capabilities and building partnerships within New Zealand and international groups and experts like Professor Teh at Monash University in Malaysia, Professor Pedell at Swinburne University of Technology, the Ageing Asia Alliance and the International Society of Gerontechnology. All these strategic relationships create access to existing expertise. Learning from those who have collaboratively developed technology and led successful clinical trials, such as QuantumTx and the National University of Singapore, will also aid in managing costs while leveraging their insights.

Developing a culture of innovation that enables collaboration between the community, academic sector, and government agencies will position New Zealand to better prepare for becoming a super-aged society. This framework for collaboration has already been successfully implemented in the Ageing Well National Science Challenge and the expertise, existing networks and previous groundwork could be leveraged to set the stage for New Zealand to become a future leader in gerontechnology, ensuring that our growing ageing population, health system, workforce, and whānau caregivers all benefit from these advancements.

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Appendices

Methodology

a. Literature search: databases and keywords

| SEARCH STRATEGY | |
|---|---|
| Databases Searched: | Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations, Daily and Versions <1946 to March 15, 2024>, adapted for PsycInfo, Embase, Scopus |
| Key Terms used in the Search Strategy: | 1 ("aging in place" or "ageing in place").mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms, population supplementary concept word, anatomy supplementary concept word] |
| | 2 Independent Living/ |
| | 3 "independent living".mp. |
| | 4 ((ageing or aging) adj2 independent).mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms, population supplementary concept word, anatomy supplementary concept word] |
| | 5 ((base or remain) adj2 home).mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms, population supplementary concept word, anatomy supplementary concept word] |
| | 6 "community dwelling".mp |
| | 7 "living alone".mp. |
| | 8 1 or 2 or 3 or 4 or 5 or 6 or 7 |
| | 9 (telehealth or tele-health or telemedicine or tele-medicine or telecare or tele-care).mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms, population supplementary concept word, anatomy supplementary concept word] |
| | 10 exp Telemedicine/ or exp remote sensing technology/ |
| | 11 Remote Consultation/ |
| | 12 robot.mp. |
| | 13 gerontech.mp. |
| | 14 ((remote or virtual) adj3 monitor).mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms, population supplementary concept word, anatomy supplementary concept word] |
| | 15 mobile tech.mp. or Mobile Applications/ |

| |
|--|
| 16 Wearable Electronic Devices/ or wearable.mp. or Monitoring, Ambulatory/ or Monitoring, Physiologic/ |
| 17 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 |
| 18 8 and 17 |
| 19 kaumatua.mp. |
| 20 Aging/ or elder.mp. or Aged/ or "Aged, 80 and over"/ |
| 21 (aging or ageing or elder).mp. |
| 22 (old adj3 (adult or person or people)).mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms, population supplementary concept word, anatomy supplementary concept word] |
| 23 (old adj3 (men or man or women or woman)).mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms, population supplementary concept word, anatomy supplementary concept word] |
| 24 "senior citizen".mp. |
| 25 ("late life" or "later life").mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms, population supplementary concept word, anatomy supplementary concept word] |
| 26 geriatric.mp. |
| 27 gerontology.mp. |
| 28 (aged adj3 (people or person or adult)).mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms, population supplementary concept word, anatomy supplementary concept word] |
| 29 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 |
| 30 18 and 29 |
| 31 exp Dementia/ or dementia.mp. |
| 32 Loneliness/ or Social Isolation/ or lonel.mp. |
| 33 31 or 32 |
| 34 30 and 33 |
| 35 8 and innovat.mp. and 29 [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms, population supplementary concept word, anatomy supplementary concept word] |
| 36 33 and 35 |
| 37 limit 36 to (english language and yr="2019 -Current") |

b. Eligibility criteria: Inclusion/exclusion criteria for selecting studies

Inclusion Criteria:

1. Population:

- Older adults (65 and over generally), formal and informal caregivers.
- Older adults with cognitive impairment or dementia.
- Older adults experiencing loneliness or social isolation.

2. Concept:

- Technological innovations.
- Interventions aimed at cognitive improvement.
- Dementia care strategies.
- Reducing loneliness and social isolation.
- Social inclusion initiatives.

3. Context:

- English language only reported studies.
- Studies conducted in community settings, healthcare facilities, and residential care homes.
- Research relevant to both rural and urban settings.

4. Types of Evidence Source:

- Review articles summarising current research.
- Peer reviewed journal articles.
- Empirical studies with qualitative or quantitative data.
- Case studies of interventions or programs.

Exclusion Criteria:

- Studies not involving relevant populations.
- Studies outside the relevant context.
- Studies not in English

c. Screening

The screening process used was as follows:

- A review of the titles and abstracts of identified sources to determine their relevance based on predefined inclusion criteria.
- Additional inclusion criteria of "Review" was added.
- Titles were reviewed for further predefined inclusion criteria.
- Abstracts of identified sources were reviewed to determine their relevance based on predefined inclusion criteria.

- Full text reviews were conducted for free and accessible sources to confirm their eligibility.

d. Data charting (data extraction) Process

A standard template was used to systematically extract, and record information collected. The data captured from each study was as follows:

1. Article ID: N.o used as an identifier to easily reference each article.
2. Citation Details:
Author(s), year of publication, title of the study.
Journal or source of publication and DOI/link. APA Format.
3. Objective/Research Question:
The main aim or research question addressed by the study.
4. Study Design/Methodology:
Type of research conducted (e.g., systematic review, metaanalysis, empirical study, case study).
5. Population/Participant:
Characteristics and demographics of participants (e.g., older adults, individuals with dementia, community dwelling individuals).
6. Type of Intervention:
Specific interventions examined (e.g., assistive technologies, telehealth, cognitive training).
7. Key Findings/Results:
Main outcomes and results related to study ie. cognitive function, social isolation, independence, etc.
8. Recommendations for Policymakers:
Policy implications and recommendations based on the study's findings.

e. Review

Two reviewers independently checked the title and abstract from each study to check inclusion criteria and minimise false search results. Terms and results were discussed between the two reviewers where necessary.

f. Data Management

Endnote 20, a referencing data management software as well as Excel was used to organise and store extracted data, maintaining a clear audit trail of data extraction decisions and processes.

Results

Flow diagram to demonstrate the application of the inclusion/exclusion criteria.

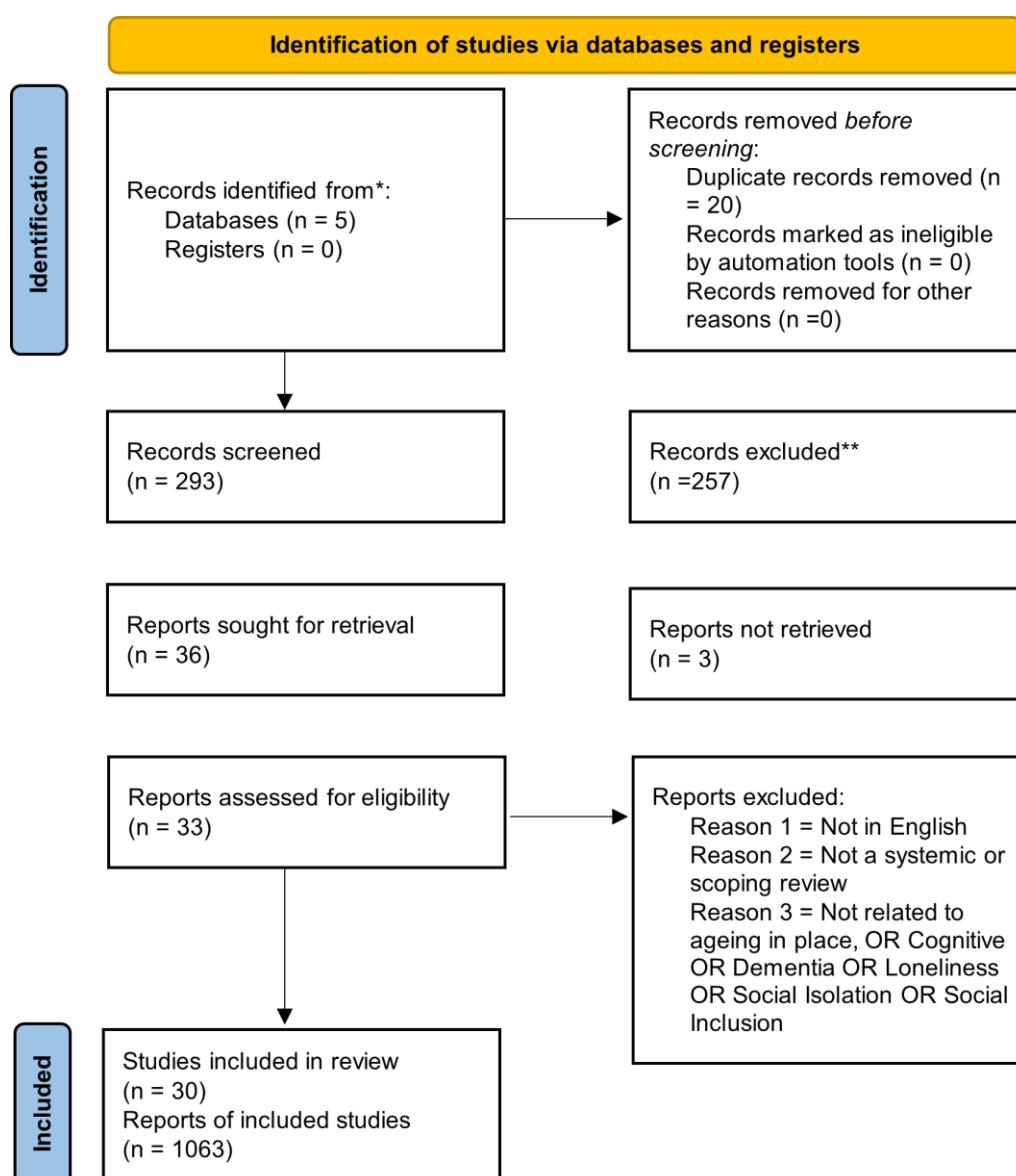


Table 6 - Summary of Literature Review - Studies that met the inclusion criteria

| # | Citation (APA) | Objective/ Research Question | Study Design/ Methodology | Population/ Participant | Type of Intervention | Key Findings/ Results | Recommendations for Policymakers | Country |
|---|---|---|--|--|---|---|---|---|
| 1 | Boyle, L. D., Husebo, B. S., & Vislapuu, M. (2022). Promotors and barriers to the implementation and adoption of assistive technology and telecare for people with dementia and their caregivers: a systematic review of the literature. <i>BMC health services research</i> , 22(1), 1573. https://doi.org/https://dx.doi.org/10.1186/s12913-022-08968-2 | To identify promotors and barriers to the implementation and adoption of Assistive Technology and Telecare (ATT) for people with dementia (PwD) and their caregivers. | Systematic review of literature using PRISMA guidelines. 30 studies were included, comprising qualitative, quantitative, and mixed-methods studies. | People with dementia and their informal (family and friends) and formal (healthcare professionals) caregivers. | Assistive Technology and Telecare (ATT). Included telehealth, e-health, telemedicine, telecare, assistive technology, wearable sensors, smart homes, digital devices and socially assistive robots. | Promotors included personalised training, safety, stakeholder involvement, ease of use, and cultural relevance. Barriers included unintended adverse consequences, timing, technology anxiety, system failures, and the digital divide. | Focus on co-design, stakeholder involvement, and adaptability of ATT solutions over time. Develop clear pre-implementation and implementation strategies, manage risks, involve all stakeholders, ensure cultural match and provide continuous evaluation and training. | 65 countries across 5 continents including: Australia, Canada, China, Denmark, Finland, France, Germany, India, Italy, Japan, Netherlands, Norway, Pakistan, Sub Saharan Africa, Sweden, Switzerland, UK, and the USA. |
| 2 | Chae, H. J., & Lee, S. H. (2023). Effectiveness of online-based cognitive intervention in community-dwelling older | To examine the effectiveness | Systematic review and meta-analysis. | Community-dwelling older adults with | ICT-based cognitive interventions. | ICT-based cognitive interventions significantly | Expand the application of ICT-based cognitive training to | 18 countries including Australia, Belgium, |

| | | | | | | | | |
|-----------------|--|--|--|------------------------------|---------------------------------------|--|--|---|
| | <p>adults with cognitive dysfunction: A systematic review and meta-analysis [Health & Mental Health Treatment & Prevention 3300]. International Journal of Geriatric Psychiatry, 38(1), 1-22. https://doi.org/https://dx.doi.org/10.1002/gps.5853</p> | <p>ss of an ICT-based cognitive intervention in community-dwelling older adults with mild cognitive impairment (MCI) or mild dementia.</p> | <p>44 studies were included.</p> | <p>MCI or mild dementia.</p> | | <p>improved cognitive function and reduced depression in older adults with MCI or mild dementia.</p> | <p>community-dwelling older adults with MCI or mild dementia. Nurses should play a pivotal role in facilitating this intervention.</p> | <p>Canada, China, France, Germany, Greece, Hong Kong, Italy, Netherlands, Norway, Portugal, Slovakia, South Korea, Spain, Taiwan, UK, and the USA</p> |
| <p>3</p> | <p>Cheng, Z., Zhou, M., & Sabran, K. (2024). Mobile app-based interventions to improve the well-being of people with dementia: a systematic literature review. Assistive technology: the official journal of RESNA, 36(1), 64-74. https://doi.org/https://dx.doi.org/10.1080/10400435.2023.2206439</p> | <p>To review mobile app-based interventions designed for people with dementia (PwD).</p> | <p>Systematic literature review. 20 papers were eligible, covering various intervention types and assessment methods.</p> | <p>People with dementia.</p> | <p>Mobile app-based interventions</p> | <p>Serious games, recall therapy, and musical mobile apps were effective in improving cognitive abilities and slowing memory loss in PwD.</p> <p>Personal life mobile apps assisted in improving</p> | <p>Encourage the development and use of mobile app-based interventions for people with dementia, focusing on cognitive enhancement and independent living.</p> | <p>Info not freely available</p> |

| | | | | | | | | |
|----------|---|--|---|--|---|---|---|--|
| | | | | | | independent living. | | |
| 4 | Corbett, C. F., Wright, P. J., Jones, K., & Parmer, M. (2021). Voice-Activated Virtual Home Assistant Use and Social Isolation and Loneliness Among Older Adults: Mini Review. <i>Frontiers in public health</i> , 9, 742012. https://doi.org/https://dx.doi.org/10.3389/fpubh.2021.742012 | To explore the relationship between voice-activated virtual home assistant (VHA) use and social isolation and loneliness among older adults. | Mini review. Examined 7 studies . | Older adults. | Voice-activated virtual home assistant (VHA) use. Technologies included Amazon Echo – Alexa, Google Nest, Xiaomi XiaoAI | VHAs improved social connectedness and reduced loneliness among older adult users. However, privacy concerns, ethical issues, and costs were identified as potential risks. | Develop a regulatory and education framework associated with VHA use. Support the age-friendly and responsive approach to the development and implementation of VHAs. Ensure training programs for older adults and caregivers are available to enable the effective use of VHAs. Address privacy concerns. | 3 countries including, Germany, China and USA |
| 5 | Dequanter, S., Gagnon, M.-P., Ndiaye, M.-A., Gorus, E., Fobelets, M., Giguere, A., Bourbonnais, A., & Buyl, R. (2021). The Effectiveness of e-Health Solutions for Aging with Cognitive Impairment: A Systematic Review. <i>The Gerontologist</i> , 61(7), e373-e394. | Synthesise the evidence on the effectiveness of e-Health solutions in supporting ageing | Systematic review conducted following the PRISMA guidelines. A total of 72 studies were included in this review. | The review targeted studies involving seven databases, focusing on studies published after 2013, assessing the effectiveness | The interventions included cognitive training, educational and supportive web platforms for caregivers, and monitoring | There were positive effects of cognitive training technologies on cognitive functioning of older adults. Supportive | Develop and implement clear guidelines to address legal and ethical issues related to e-health solutions. Promote co-design with older adults, caregivers and | 18 countries including Australia, Belgium, Canada, China, France, Finland, Denmark, Germany, Switzerland, |

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| | <p>https://doi.org/https://dx.doi.org/10.1093/geront/gnaa065</p> | <p>with cognitive impairment and their availability</p> | | <p>of 70 e-Health solutions for community-dwelling older adults with cognitive impairment or informal caregivers</p> | <p>technologies to support activities of daily living and safety. Technologies included cognitive training, electronic memory aids, mobile technologies (tablets, handheld devices, wearables), video games (exergame in nature), virtual reality, telemedicine/telehealth, monitoring technologies (sensors, geotracking etc), mobile applications, multimedia art and or music based apps, technology based</p> | <p>web platforms showed positive effects on behavioural and psychological symptoms of dementia and caregiver self-efficacy. The solutions showed positive effects on cognitive functioning and caregiver self-efficacy. Inconclusive effects on depression. The evidence was moderate to good in methodological quality.</p> | <p>healthcare providers. Ensure accessibility and affordability of e-health solutions. Provide training and support for caregivers and patients to enhance the effectiveness of e-health technologies</p> | <p>Italy, Japan, South Korea, Netherlands Norway, Spain, Sweden, UK, and the USA.</p> |
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| | | | | | cognitive behavioural therapy. | | | |
| 6 | El-Saifi, N., Moyle, W., Jones, C., & Tuffaha, H. (2018). Medication Adherence in Older Patients with Dementia: A Systematic Literature Review. <i>Journal of pharmacy practice</i> , 31(3), 322-334. https://doi.org/https://dx.doi.org/10.1177/0897190017710524 | To review evidence on medication adherence in older patients with dementia. | Systematic literature review. 20 articles were included. | Older patients with dementia. | Medication adherence interventions. The technologies included medication event monitoring systems, electronic pill dispensers and telehealth home monitoring. | Older patients with dementia have low medication adherence rates. Factors influencing adherence include cognitive impairment, complex medication regimens and the support of caregivers. Telehealth home monitoring and treatment modifications were effective interventions. | Develop and implement interventions to improve medication adherence in older patients with dementia. Improve caregiver support systems and leverage gerontechnology (technological aids – reminders or dispensers) | 10 countries including US A, Australia, Canada, Ireland, France, Germany, South Korea, Finland, Spain and Netherlands |

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| 7 | <p>Gan, D. R. Y., Mann, J., & Chaudhury, H. (2024). Dementia care and prevention in community settings: A built environment framework for cognitive health promotion [Review]. <i>Current Opinion in Psychiatry</i>, 37(2), 107-122. https://doi.org/10.1097/YCO.0000000000000917</p> | <p>To identify frameworks for dementia care and prevention in community settings.</p> | <p>Systematic search, synthesised 61 studies into the dementia care and prevention in community (DCPC) framework.</p> | <p>People living with cognitive decline (PLCD).</p> | <p>Built environment and policy supports, access and innovation, and inclusion across stages of cognitive decline.</p> | <p>The DCPC framework highlights provisions and domains of intervention for dementia care and prevention in community settings.</p> | <p>Develop clear guidelines to address legal and ethical issues. Promote co-design with relevant stakeholders. Ensure accessibility and affordability of technologies and provide continuous training and support for caregivers and users. Foster inclusive community environments that support personhood and social identity.</p> | <p>18 countries including Australia, Canada, China, France, Finland, Denmark, Germany, Switzerland, Italy, Japan, South Africa South Korea, Netherlands Norway, Spain, Sweden, UK, and the USA.</p> |
| 8 | <p>Ganesan, B., Gowda, T., Al-Jumaily, A., Fong, K. N. K., Meena, S. K., & Tong, R. K. Y. (2019). Ambient assisted living technologies for older adults with cognitive and physical impairments: a review. <i>European review for medical and pharmacological sciences</i>, 23(23), 10470-10481.</p> | <p>Objective: Investigate ambient and active assisted living technologies for enhancing independence in</p> | <p>Review of current technologies. A total of 93 studies were referenced in this review.</p> | <p>Older adults with physical and cognitive impairments, primarily in developing countries.</p> | <p>Implementation of ambient and active assisted living technologies.</p> | <p>Technologies effectively support safe, independent living and improve mental and physical health.</p> | <p>New Zealand could lead in developing and promoting such technologies, focusing on accessibility and sustainability, tailored for an ageing population.</p> | <p>There were 3 countries included in this review, they were: Australia, China, and India.</p> |

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| | https://doi.org/https://dx.doi.org/10.26355/eurrev_201912_19686 | older adults with physical and cognitive impairments. | | | | | | |
| 9 | Gettel, C. J., Chen, K., & Goldberg, E. M. (2021). Dementia Care, Fall Detection, and Ambient-Assisted Living Technologies Help Older Adults Age in Place: A Scoping Review. <i>Journal of applied gerontology: the official journal of the Southern Gerontological Society</i> , 40(12), 1893-1902. https://doi.org/https://dx.doi.org/10.1177/07334648211005868 | Objective: Describe technological advances in dementia care, fall detection, and living assistance to support ageing in place. | Scoping review of recent literature. A total of 54 studies were included in this review. | Older adults. | Technologies for dementia care, fall prevention, and assisted living. | High usability of technologies ; however, adoption hindered by privacy concerns and user experience issues. | Address privacy and user experience concerns in New Zealand's technology deployments. Increase public and professional knowledge about the benefits and operation of these technologies. | There were 5 countries included in this review, they were: France, Germany, Italy, UK, and the USA. |
| 10 | Ghafurian, M., Hoey, J., & Dautenhahn, K. (2021). Social Robots for the Care of Persons with Dementia: A Systematic Review [Article]. <i>ACM Transactions on Human-Robot Interaction</i> , 10(4), Article 3469653. https://doi.org/10.1145/3469653 | Review the effectiveness of socially assistive robots in dementia care. | Systematic review across 16 countries. A total of 53 articles were included in this review. | People with dementia. | Social robots for therapeutic and engagement purposes. | Robots improve quality of life and social interaction, reduce caregiver stress. | New Zealand should invest in research and development of cost-effective, socially assistive robots for aged care. | There were 16 countries included in this review, they were: Australia, Austria, Canada, China, Denmark, France, Ireland, Italy, |

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| | | | | | | | | Japan, Netherlands, New Zealand, Norway, Poland, Spain, UK, and the USA. |
| 11 | Gorenko, J. A., Moran, C., Flynn, M., Dobson, K., & Konnert, C. (2021). Social Isolation and Psychological Distress Among Older Adults Related to COVID-19: A Narrative Review of Remotely Delivered Interventions and Recommendations [Review]. <i>Journal of Applied Gerontology</i> , 40(1), 3-13. https://doi.org/10.1177/0733464820958550 | Evaluate the effectiveness of remotely delivered interventions for reducing loneliness and psychological symptoms among older adults during the COVID-19 pandemic. | A total of 19 studies were included in this narrative review. | Older adults. | Remote interventions (e.g., telephone or video call based). | Effective in reducing loneliness and psychological distress. | Develop and fund remote intervention programs tailored to the needs of New Zealand's older adult population, ensuring digital accessibility and support. | There were 8 countries included in this review, they were: Australia, Canada, England, Netherlands, Scotland, Sweden, Taiwan, and the USA. |
| 12 | Gunnes, M., Loe, I.-C., & Kalseth, J. (2024). Exploring the impact of information and communication technologies on loneliness and social isolation in community- | Examine the role of ICT in mitigating loneliness | Scoping review of reviews. A total of 39 publications | Community-dwelling older adults. | ICT-based interventions. | Positive impacts from social media, virtual communities | Promote broader access to and education about ICT for older adults in New Zealand, | "Most reviews were conducted in the North American, |

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| | dwelling older adults: a scoping review of reviews. BMC Geriatrics, 24(1), 215. https://doi.org/https://dx.doi.org/10.1186/s12877-024-04837-1 | and social isolation among community-dwelling older adults. | were included in this review. | | | , and other ICTs in reducing isolation. | focusing on user-friendly and inclusive designs. | European and Western Pacific regions, with several of the primary studies represented from the USA and the Netherlands. " |
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| 13 | He, X., Hao, J., Song, Y., Cao, H., Chen, Y., & Yang, H. (2023). Effectiveness of non-pharmacological interventions for sleep disturbances in people living with dementia: A systematic review and meta-analysis [Article]. Geriatric Nursing, 51, 76-83. https://doi.org/10.1016/j.gerinurse.2023.02.009 | To evaluate the effectiveness of non-pharmacological interventions for sleep disturbances in people living with dementia. | Systematic review and meta-analysis. 6 studies. | People living with dementia. | Non-pharmacological interventions like light therapy, therapeutic pet-type robotic seals (PARO), and slow-stroke back massage. | Light therapy and PARO showed improvements in sleep duration and efficiency; however, evidence for the effectiveness of slow-stroke back massage remains unclear. | Encourage the adoption of proven non-pharmacological interventions to improve sleep among dementia patients, potentially reducing reliance on pharmacological treatments. | 3 countries specified Norway, USA and Australia |
| 14 | Hill, J. R., Min, E. E., Abebe, E., & Holden, | Understand the demographic, experiences, | Mapping review including 61 publications that | Informal caregivers of older adults | Technological and non-technological | Variety of outcomes focused on user | Invest in robust research and development to | 14 countries including |

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| | R. J. (2024). Telecaregiving for Dementia: A Mapping Review of Technological and Nontechnological Interventions. <i>The Gerontologist</i> , 64(1). https://doi.org/https://dx.doi.org/10.1093/geront/gnad026 | challenges, and interventions available in telecaregiving for dementia. | represented 48 studies . | with Alzheimer's disease and related dementias. | telecaregiving interventions. | experience, highlighting a lack of comprehensive studies on the needs of telecaregivers. | improve telecaregiving solutions, ensuring they meet caregiver needs effectively. | the USA, UK, Sweden, Canada, Norway, the Netherlands, Ireland, Germany, Spain, Romainia, Italy, Taiwan, Japan and Australia |
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| 15 | Hirt, J., Ballhausen, N., Hering, A., Kliegel, M., Beer, T., & Meyer, G. (2021). Social robot interventions for people with dementia: A systematic review on effects and quality of reporting [Article]. <i>Journal of Alzheimer's Disease</i> , 79(2), 773-792. | Assess the effects and report quality of social robot interventions for people with dementia. | A total of 16 studies were included in this systematic review. | People with dementia. | Social robots, particularly pet robots like PARO. | Mixed results on behavioural, emotional, and functional outcomes, with cognitive outcomes not improved. | Further research to determine the effective use of social robots in dementia care, considering the severity and individual characteristics. | There were 9 countries included in this review, they were: Australia, France, Norway, Japan, Netherlands, New Zealand, Spain, Sweden, |
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| | https://doi.org/10.3233/JAD-200347 | | | | | | | and the USA. |
| 16 | Khan, S. S., Gu, T., Spinelli, L., & Wang, R. H. (2023). Sensor-based assessment of social isolation in community-dwelling older adults: a scoping review. <i>Biomedical engineering online</i> , 22(1), 18. https://doi.org/https://dx.doi.org/10.1186/s12938-023-01080-4 | Explore the application of sensor-based technologies to assess social isolation among community-dwelling older adults. | A total of 8 articles were included in this scoping review. | Community-dwelling older adults. | Sensor-based assessments using motion sensors and actigraphs. | Sensors effectively assess social interaction, highlighting the need for clear definitions and methodological consistency. | Develop guidelines for the use of sensor technologies to monitor social isolation, focusing on ethical considerations and privacy. | There were 8 countries included in this review, they were: Denmark, Ireland, Mexico, Singapore, Spain, Germany, UK, and the USA. |
| 17 | Kim, D., Bian, H., Chang, C. K., Dong, L., & Margrett, J. (2022). In-Home Monitoring Technology for Aging in Place: Scoping Review. <i>Interactive journal of medical research</i> , 11(2), e39005. https://doi.org/https://dx.doi.org/10.1186/s12938-023-01080-4 | Review the use of in-home monitoring technologies to support ageing in place. | Scoping review. 30 studies | Older adults. | Smart home technologies for health monitoring. | Technologies effectively monitor daily activities and health, aiding ageing in place. | Promote the integration of smart home technologies in senior housing developments to support independent living. | Not specified but main institutes referred to are from 2 countries USA and Poland |

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| | //dx.doi.org/10.2196/39005 | | | | | | | |
| 18 | <p>Ma, C., Guerra-Santin, O., & Mohammadi, M. (2022). Smart home modification design strategies for ageing in place: a systematic review [Article]. <i>Journal of Housing and the Built Environment</i>, 37(2), 625-651. https://doi.org/10.1007/s10901-021-09888-z</p> | <p>Strategies and approaches to integrate innovative technologies in the home modification process to support independent living and ageing in place is explored</p> | <p>A systematic review that included 33 articles from the fields of architecture, smart technology, and gerontology, focusing on the integration of smart technologies into home environments for ageing in place.</p> | <p>Direct participants are not involved but focuses on the broader demographic of older adults who could benefit from smart home modifications to support ageing in place</p> | <p>Smart home modifications for ageing in place and integration of smart technologies and architectural design. Technologies Included are assistive technologies, ambient intelligence, ambient assisted living, IoT, ICT and other smart technologies aimed at enhancing safety, health monitoring, living environment control, and social interaction</p> | <p>Both home modification and smart technologies support older adults' independent living, especially concerning fall prevention and indoor accessibility. Technologies in homes are transitioning from manual assistive technology to more intelligent devices, with a growing trend towards the concept of the robotic home</p> | <p>A need for further development and integration of smart technologies with architectural design to address ageing in place effectively. It highlights the importance of using universal design as a strategy for smart home design and modification, emphasising customisation, minimal life interference, and extensible technologies to accommodate the ageing process</p> | <p>There were 10 countries and one region (Europe) included in this review, they were: Australia, Finland, Germany, Israel, Netherlands, New Zealand, and the USA. Europe Republic of Korea France Slovenia</p> |

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| | | | | | for older adults. | | | |
| 19 | Moreno, A., Scola, M. C., Sun, H., Durce, H., Couve, C., Acevedo, K., & Gutman, G. M. (2023). A systematic review of gerontechnologies to support aging in place among community-dwelling older adults and their family caregivers. <i>Front Psychol</i> , 14, 1237694. https://doi.org/10.3389/fpsyg.2023.1237694 | Evaluate the effectiveness and challenges of ageing in place gerontechnologies in dyads of community-dwelling older adults with unimpaired cognition and family caregivers. | PRISMA Systematic Review (2016-2021) A total of 13 studies were included in this review. | 172 older adults (mean age 78.5years) and 134 family caregivers (mean age 51.7years) | The application of monitoring, communication, daily life and health information technologies. Examples included eHomecare, QuietCare, The Lab of Things (LoT), sensor systems and VHA – virtual home assistants | Only 13/1441 studies met the inclusion criteria. Gerontechnologies were used for monitoring, increasing communication with family caregivers, assisting in daily activities, and providing health information. They achieved their goals and were reported to increase safety and reduce stress for family caregivers. The other benefits were taking better of their health and increased participation in health care decisions. | Ensure ease of use, a match of technologies to users' needs and physical abilities and improve sensitivity to privacy. Support a co-construction approach with communities, technical experts, and academia. Provide access to information and training on gerontechnology with end-users and clinicians and fund further research that evaluates the cost-effectiveness of interventions using gerontechnology. | There were 8 countries included in this review, they were: Australia, Chile, Croatia, Sweden, Switzerland, Taiwan, Japan and the USA. |

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| | | | | | | Challenges included, user difficulty, technical problems, privacy issues, increased stress and dissatisfaction of older adult users and the perceived mismatch between values and needs. | | |
| 20 | Moret-Tatay, C., Iborra-Marmolejo, I., Jorques-Infante, M. J., Esteve-Rodrigo, J. V., Schwanke, C. H. A., & Irigaray, T. Q. (2021). Can Virtual Assistants Perform Cognitive Assessment in Older Adults? A Review. <i>Medicina (Kaunas, Lithuania)</i> , 57(12). https://doi.org/https://dx.doi.org/10.3390/medicina57121310 | Explore the development and application of digital devices, specifically virtual assistants for detecting cognitive impairment in older adults. | Systematic review following PRISMA guidelines, using databases like PubMed. A total of 8 studies were included in this review. | Older adults, particularly those who may experience cognitive impairment. | Use of virtual assistants for cognitive assessment. Technologies used included virtual assistants, tablet based applications | Found limited but promising evidence on the use of virtual assistants for cognitive assessment. Virtual assistants can reduce barriers to technology adoption by relying on speech rather than manual input | Further exploration and development of virtual assistants for cognitive assessment are needed. | There were 5 countries included in this review, they were: USA, South Korea, Japan, Canada and Italy |

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| <p>21</p> | <p>Nkodo, J.-A., Gana, W., Debacq, C., Aidoud, A., Poupin, P., Camus, V., & Fougere, B. (2022). The role of telemedicine in the management of the behavioral and psychological symptoms of dementia: A systematic review [Health & Mental Health Services 3370]. The American Journal of Geriatric Psychiatry, 30(10), 1135-1150. https://doi.org/https://dx.doi.org/10.1016/j.jagp.2022.01.013</p> | <p>Review the role of telemedicine in managing behavioural and psychological symptoms of dementia.</p> | <p>Systematic review, including 22 studies.</p> | <p>Patients with dementia.</p> | <p>Telemedicine.</p> | <p>Telemedicine (TM) is acceptable and feasible and can reduce symptoms of dementia and improve caregiver wellbeing. Videoconferencing was effective for patient-centered interventions in nursing homes.</p> | <p>Expand telemedicine services to ensure continued care for dementia patients, especially in remote areas. Focus on broader adoption to enhance access to specialist care. Address the availability of stable internet.</p> | <p>There were 4 countries included in this review, they were: USA, Hong Kong, Canada, Netherlands</p> |
| <p>22</p> | <p>Phang, J. K., Kwan, Y. H., Yoon, S., Goh, H., Yee, W. Q., Tan, C. S., & Low, L. L. (2023). Digital Intergenerational Program to Reduce Loneliness and</p> | <p>Identify existing digital intergenerational programs used to reduce loneliness or social isolation among older adults and analyse them.</p> | <p>Realist review with extensive literature search. A total of 31 documents reporting 27 digital intergenerational</p> | <p>Programs targeting older adults who experienced loneliness or social isolation.</p> | <p>Digital intergenerational programs including the use of digital communication tools.</p> | <p>Identified strategy-context-mechanism-outcome configurations that explain how programs can reduce loneliness</p> | <p>Future programs need to consider different strategies based on the characteristics of the older adults and their living environments.</p> | <p>There were 12 countries included in this review, they were: Australia, Belgium,</p> |

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| | <p>Social Isolation Among Older Adults: Realist Review. JMIR aging, 6, e39848. https://doi.org/https://dx.doi.org/10.2196/39848</p> | | <p>l programs were reviewed.</p> | | | <p>and social isolation.</p> | | <p>Canada, Mexico, Netherlands, Northern Ireland, Norway, Portugal, Sweden, Taiwan, UK, and the USA.</p> |
| <p>23</p> | <p>Piau, A., Wild, K., Mattek, N., & Kaye, J. (2019). Current State of Digital Biomarker Technologies for Real-Life, Home-Based Monitoring of Cognitive Function for Mild Cognitive Impairment to Mild Alzheimer Disease and Implications for Clinical Care: Systematic Review. Journal of medical Internet research, 21(8), e12785. https://doi.org/https://dx.doi.org/10.2196/12785</p> | <p>Assess the state of digital biomarker technologies for home-based monitoring of cognitive function.</p> | <p>A total of 26 studies were included in this systematic review.</p> | <p>Older adults with mild cognitive impairment or mild Alzheimer's disease.</p> | <p>Digital biomarker technologies such as sensors (wearable, environmental) games etc.</p> | <p>Digital biomarkers are promising for the long-term monitoring of cognitive function.</p> | <p>Encourage the development of standards for digital biomarkers and increase research focus. Promote user-centred design to improve usability and acceptance. Address privacy and ethical concerns related to the use of digital health technologies.</p> | <p>There were 9 countries included in this review, they were: Canada, France, Germany, Greece, Israel, Japan, Switzerland, UK, and the USA.</p> |

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| 24 | Rashid, N. L. A., Leow, Y., Klainin-Yobas, P., Itoh, S., & Wu, V. X. (2023). The effectiveness of a therapeutic robot, 'Paro', on behavioural and psychological symptoms, medication use, total sleep time and sociability in older adults with dementia: A systematic review and meta-analysis [Review]. <i>International Journal of Nursing Studies</i> , 145, Article 104530. https://doi.org/10.1016/j.ijnurstu.2023.104530 | Evaluate the effectiveness of the therapeutic robot 'Paro' on behavioural and psychological symptoms, medication use, total sleep time, and sociability in older adults with dementia. | A total of 12 articles were included in this systematic review and meta-analysis with narrative synthesis. | Older adults aged 60 years and above with any form of dementia, residing in the community, nursing homes, or care facilities. | Use of the therapeutic robot 'Paro'. | Paro had a moderate effect on reducing medication use and a small effect on reducing anxiety, agitation, and depression. However, it had negligible impact on total sleep time. Paro also reduced apathy and increased sociability. | Encourage the use of non-pharmacological interventions like Paro to improve behavioural and psychological symptoms and reduce medication use. More rigorous studies with larger sample sizes are needed to understand its full benefits. | There were 6 countries included in this review, they were: Australia, South Korea, New Zealand, Norway, Spain and the USA. |
| 25 | Read, E., Woolsey, C., Donelle, L., Weeks, L., & Chinho, N. (2023). Passive | Assess the effectiveness of passive remote monitoring | A total of 14 articles were included in this scoping review. | Older adults and their caregivers. | Passive remote monitoring (PRM) | These technologies can contribute to perceived safety | Promote further research into passive remote monitoring to | There were 6 countries included |

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| | Remote Monitoring and Aging in Place: A Scoping Review [Article]. Canadian Journal on Aging, 42(1), 20-32. https://doi.org/10.1017/S0714980822000198 | technologies in supporting older adults to age in place. | | | technologies including sensors, video cameras, smart plugs, home alarm systems, voice response etc | and security among older adults, delaying institutionalisation in some cases. PRM can provide valuable health data for caregivers or health practitioners. Privacy concerns vary impacting adoption. | provide robust evidence for its efficacy and to guide its implementation in ageing-in-place strategies. Promote user-centred design to enhance acceptance and usability and address | in this review, they were: Germany, Greece, Ireland, Japan, Netherlands, and the USA. |
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| 26 | Schneider, C., Nisen, M., Kowatsch, T., & Vinay, R. (2024). Impact of digital assistive technologies on the quality of life for people with dementia: a scoping review. BMJ open, 14(2), e080545. https://doi.org/https://dx.doi.org/10.1136/bmjopen-2023-080545 | Review the impact of digital assistive technologies (DATs) on the quality of life (QOL) for people with dementia. | Scoping review using Arksey and O'Malley framework and PRISMA-ScR guidelines. A total of 122 studies were included in this review. | People with dementia (PWD) living in diverse settings with varying severities of dementia. | Various digital assistive technologies including patient monitoring devices, health clinical software etc. | DATs support autonomy, engagement, social interaction, health monitoring, and safety for PWD, improving their QOL. | Support the development and integration of diverse DATs to enhance the QOL of PWD. Focus on underrepresented digital health technology categories in future research. | There were 31 countries included in this review, they were: Australia, Brazil, Canada, China, Cyprus, Czech Republic, Denmark, France, Germany, Greece, |
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| | | | | | | | | India, Indonesia, Italy, Malaysia, Malta, Japan, Netherlands, New Zealand, Norway, Pakistan, Portugal, Qatar, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, UK, and the USA. |
| 27 | Sriram, V., Jenkinson, C., & Peters, M. (2019). Informal carers' experience of assistive technology use in dementia care at home: a systematic review. BMC Geriatrics, | Investigate the outcomes and experiences of informal carers using assistive technology in dementia care at home. | A total of 56 publications were included in this systematic review. | Informal carers of people with dementia living at home. | Assistive technology devices (e.g., electronic medication dispensers, robotic devices, trackers, | Carers appreciated the use of assistive technology, although their experiences varied. Key themes included knowledge and | Develop a standard and person-centred system for classifying assistive technology devices. Encourage research that incorporates a family/carer-centred model. | There were 21 countries included in this review, they were: Australia, Belgium, |

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| | 19(1), 160. https://doi.org/https://dx.doi.org/10.1186/s12877-019-1169-0 | | | | motion detectors, safety alarms, video monitoring, memori aids, simplified mobile phones). | acceptance, competence to use, and ethical issues. | | Canada, England, Finland, France, Germany, Ireland, Israel, Japan, Lithuania, Mexico, Netherlands, Norway, Poland, Scotland, Spain, Sweden, Taiwan, UK, and the USA. |
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| 28 | Verloo, H., Lorette, A., Rosselet Amoussou, J., Gilles de Pelichy, E., Matos Queiros, A., von Gunten, A., & Perruchoud, E. (2021). Using Living Labs to Explore Needs and Solutions for Older Adults with | Explore the needs and solutions for older adults with dementia using living labs. | Scoping review following PRISMA-ScR recommendations. A total of 12 studies were included in this review. | Older adults with dementia living in the community or long-term healthcare facilities (LTHFs). | Innovations developed in 4 living labs. Technologies included SARs -Paro, Kompai and Robadom, GPS tracking, Electronic organiser, | Living labs play a pivotal role in optimising health, QOL, independent living, home care, and safety for older adults with dementia. However, methodological | Support better-quality interventional research in living labs to prove the effectiveness of their innovations. | There were 3 countries included in this review, they were: Canada, France, and the Netherlands. |
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| | Dementia: Scoping Review. JMIR aging, 4(3), e29031. https://doi.org/https://dx.doi.org/10.2196/29031 | | | | Smartphone App, | quality of studies varied. | | |
| 29 | Wilson, S. A., Byrne, P., Rodgers, S. E., & Maden, M. (2022). A Systematic Review of Smartphone and Tablet Use by Older Adults with and Without Cognitive Impairment. Innovation in aging, 6(2), igac002. https://doi.org/https://dx.doi.org/10.1093/geroni/igac002 | Explore the use of smartphones and tablets as cognitive and memory aids by older adults with and without cognitive impairment. | A total of 28 papers were included in this systematic review. | Community-dwelling older adults with or without cognitive impairment from acquired brain injury, mild cognitive impairment, or dementia. | Smartphones and tablet computers. Used as cognitive and memory aids | Smartphones and tablets can support cognitive function and memory. However, use is hindered by digital literacy, accommodation for impairments, and lack of clinician and researcher input. | Enhance digital literacy programs and design inclusive technology that accommodates motor and sensory impairments. Promote research into effective smartphone and tablet use for cognitive support. | There were 12 countries included in this review, they were: Australia, Canada, China, Denmark, France, Germany, New Zealand, Scotland, Slovenia, Spain, Sweden, and the USA. |
| 30 | Yu, C., Sommerlad, A., Sakure, L., & Livingston, G. (2022). Socially assistive robots for people | Review the feasibility, acceptability, and clinical effectiveness of socially assistive | Systematic review and meta-analysis. A total of 66 studies were | People with dementia. | Socially assistive robots (e.g., companion robots, | Robots were generally feasible and acceptable but showed no clear benefit for | Invest in high-quality research to establish the effectiveness of socially assistive | There were 16 countries included in this |

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| | <p>with dementia: Systematic review and meta-analysis of feasibility, acceptability and the effect on cognition, neuropsychiatric symptoms, and quality of life [Review]. Ageing Research Reviews, 78, Article 101633. https://doi.org/10.1016/j.arr.2022.101633</p> | <p>robots for people with dementia.</p> | <p>included in this review.</p> | | <p>telepresence communication robots, homecare assistive robots).</p> | <p>cognition, neuropsychiatric symptoms, or QOL. Issues included weight, cost, and usability.</p> | <p>robots and address usability issues.</p> | <p>review, they were: Australia, Austria, Canada, Germany, Hong Kong, India, Ireland, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Spain, UK, and the USA.</p> |
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