Exploring Artificial Intelligence Technologies and Quality of Life for Older People Ageing in Place in Super-Aged Societies

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Abstract

This discussion paper explores the possibilities of artificial intelligence (AI) driven technologies to enhance the quality of life of growing numbers of older people worldwide who are choosing to age in place at home in their communities. Population ageing is a pressing global challenge, as highlighted by the United Nations Decade of Healthy Ageing (2020-2023). The emergence of super-aged societies is generating new challenges of how to meet rising demand for care and support while also striving for equality, sustainability, and economic growth. Current evidence suggests that technologies could benefit older people who choose to age in place by supporting health and wellness, social engagement, safety and security, physical environment, nutrition and food security, independence and autonomy, spirituality and meaningful activities. Challenges include the limitations of current technologies, age-related digital marginalisation, fairness for older adults who do not have capacity to engage digitally, ageism in technology design, and the consequences of decisions to utilise or abstain from using digital technologies. Policy possibilities in the next decade centre on including older people, caregivers, and advocates in debates about AI, collaborative research and co-design practices, and co-evolution of human and technological solutions facilitated by regulatory oversight, strategies for equity and fairness, funding and investment, digital inclusion, collaboration and stakeholder engagement.

Keywords: ageing populations; quality of life; co-created technology solutions; ageing in place; assistive technologies; artificial intelligence; digital inclusion

Introduction

Between 2015 and 2050, the proportion of the world's population over 60 years will nearly double from 12% to 22%.[1] Population ageing symbolises the successes of modern societies in fostering longevity but it introduces new challenges for how to meet rising demand for care and support,[2] while also striving for equality, sustainability,[3] and economic growth.[4] Projections indicate that by 2023, there will be 35 super-aged countries– where over one in six individuals is aged 65 or older– illustrating the global scale and significance of the challenges associated with population ageing.[5] The United Nations Decade of Healthy Ageing (2020-2023) highlights the need for policies and actions that protect human rights and enable older adults to enjoy longer, healthier, and more fulfilling lives.[6]

This paper explores the possibilities of digital technology to enhance the quality of life for growing numbers of older people worldwide who are choosing to age in place at home in their community. The discussion aims to inform policy and policymaking in the next decade, focusing on emerging technologies that are driven by artificial intelligence (AI) or machine learning,[7] but not exclusively. The paper emphasises the usefulness of quality of life as a measurable concept8 and guiding principle, whist recognising the importance of not making any generalisations about quality of life experiences in older age. *Quality of life* is a multidimensional concept that encompasses many factors that contribute to a person's overall happiness and satisfaction,[9,10] such as having strong social connections, health and wellness, or financial stability.[11] Different components have different meaning and significance for individuals and may become more or less important over time as circumstances change.

This discussion focuses on how digital technologies might enhance quality of life in older age, acknowledging that they may also have negative or undesirable effects which should be guarded against. Digital technologies have become deeply ingrained in our daily lives. However, not everyone embraces this shift as progress, or is benefitting from it. Some individuals may perceive themselves as having more limited choice, feel disempowered, or disadvantaged by a digital divide.[12] Furthermore the discussion challenges assumptions

1   World Health Organization, "Ageing and Health", (accessed July 6, 2024).

2   S. Abdi et al., "Understanding the care and support needs of older people: a scoping review and categorisation using the WHO international classification of functioning, disability and health framework (ICF)", BMC Geriatrics 19 (2019): 1, 195.

3   United Nations, "Sustainable Development The 17 Goals", (accessed July 6, 2024).

4   T. Vlandas, D. McArthur, and M. Ganslmeier, "Ageing and the economy: a literature review of political and policy mechanisms", *Political Research Exchange* 3:1 (2021).

5   *World Economic Forum*, "Global Risks. These countries are ageing the fastest – here is what it will mean", (accessed July 6, 2024).

6   *World Health Organization*, "Decade of Healthy Ageing The Platform", (accessed July 6, 2024).

7   A. V. Joshi. Machine Learning and Artificial Intelligence. Springer Cham, 2020.

8   For example, established measures of quality of life are the World Health Organization Quality of Life (WHOQOL), SF-36 and SF-12 (Short Form Health Survey), EQ-5D (EuroQol Group Five-Dimension), Quality of Life Index (QOLI) and the Geriatric Depression Scale (GDS), aim to capture and quantify the complexity of quality of life.

9   J. Cleland et al., "Developing dimensions for a new preference-based quality of life instrument for older people receiving aged care services in the community", Quality of Life Research 30 (2020): 555-565.

10   C. Hutchinson et al., "What quality-of-life dimensions are most important to older adults from culturally and linguistically diverse backgrounds receiving aged care services? An exploratory study", *Geriatrics (Basel)* 7, no. 6 (2022): 144.

11   G. Netuveli and D. Blane. "Quality of life in older ages." *British Medical Bulletin* 85, no. 1 (2008): 113–126.

12   S. Lythreatis, S. Kumar Singh, and A. El-Kassar. "The digital divide: A review and future research agenda." *Technological Forecasting and Social Change* 175 (2022): 121359.

that ageing and technologies are incompatible,[13,14] as well as misconceptions that all older individuals are averse to technology,[15] although some may be. The transition to a digital society must consider people of all ages, their interactions,[16,17] and the imperative to build trustworthy technologies that enhance human lives.[18,19] People need to be assured that technologies will not replace healthcare workers and caregivers or deepen social disadvantage.[20] In a world with increasing healthcare demand and labour shortages, the astute and effective application of technology can reduce workloads by detecting health issues early, preventing declines in quality of life and mitigating labour-intensive problems.

The types of technologies concerned are currently available and emerging AI-driven health technologies, smart devices, software programmes and applications, as well as innovative and novel human-centred technologies. A wealth of previous SHAPE (Social Sciences, Humanities & the Arts for People and the Economy) research into these categories of technologies offers useful evidence to inform the discussion. For example, research into perceptions and experiences of AI in healthcare,[21,22] technology integrated ecosystems of care,[23] human and AI interactions,[24,25,26,27] and the acceptability of technologies and their use in home environments.[28] Additional relevant literatures include human-centred AI,[29] patient and public involvement,[30] human-centred technology design,[31] compassion centred design,[32,33,34,35,36] technologies that promote mutuality, positive emotions, compassion or pro-social behaviours,[37,38] with the goal of easing pain, distress, risk, or disadvantage.[39,40]

Ageing in place and quality of life

Ageing in place refers to the ability of individuals to continue living at home as they grow older, rather than relocating to assisted living facilities or nursing homes, for example, if they prefer not to. Studies internationally show that 77-88% of older individuals express a preference for ageing in their own homes, or with families and friends in their communities.[41,42,43,44] While ageing in place is a complex decision, it can bring a host of psychological and physical benefits for people who are able to maintain their independence.[45,46] A range of age-friendly strategies at the

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individual, community, service, and systemic levels are essential to support older adults to age in place safely, with dignity,[47] and cost effectively.[48] Among these strategies, technology presents a promising tool for enhancing quality of life, but there are potential challenges and limitations that also need to be considered.

Ageing in place not only directly affects older individuals and carers, it also has political, societal and sustainability implications for the provision of necessary support.[49] Countries around the globe are facing substantial healthcare workforce supply issues stemming from greater numbers of older people with more complex care needs, alongside rising demand for health and social care closer to home.[50] As a result, in many countries there are not enough unpaid caregivers or paid home support workers to meet the increasing demand for care. There is no simple solution to the growing *care gap* and a range of policies, strategies and interventions are needed to improve workforce retention and increase recruitment to health and caring roles. More research is required to develop the types of technologies that different types of caregivers can use and that will benefit older people.[51]

Quality of life is a multifaceted concept with objective measures and subjective perspectives covering a spectrum of positive and negative aspects of life. Older people's negative evaluations of quality of life tend to emphasise dependency, functional limitations, unhappiness, and reduced social contacts.[52] Conversely, seven positive components of quality of life most often expressed by older adults who are ageing in place are as follows:[53,54,55,56,57]

- Health and wellness: self-reported health status, physical mobility, mental wellbeing, access to healthcare

- Social connection and engagement: frequency of social interactions, participation in activities, feelings of belonging

- Safety and security: perceived safety, emergency preparedness, financial stability

- Physical environment: comfortable living space, access to amenities

- Nutrition and food security: access to nutritious food, affordability, ability to prepare meals

- Independence and autonomy: ability to perform daily activities, freedom to make decisions

- Spirituality and meaningful activities: participation in spiritual practices, engagement in fulfilling activities

This evidence provides a general context for the use or development of technologies however it is important to consider individual needs and preferences. Changes in personal circumstances such as financial difficulties and events such as the COVID-19 pandemic, or loneliness, can also affect older people's views and experiences of how technologies might improve their quality of life.[58,59]

The next part of the discussion explores the types of digital technologies that may contribute to addressing the care gap and enhancing quality of life.

Technology to support quality ageing in place

The emerging technology landscape in the care and support field is vast and growing rapidly.[60,61] Here we will provide a scan of the current landscape to contextualise the policy possibilities provided later in the paper. We will delve into the seven positive components of quality of life identified in the previous section.

Promoting Health and Wellness

In some countries new forms of health and care technologies are enhancing health related quality of life[62] for ageing populations by offering virtual appointments, remote monitoring, and clinical management at home.[63] The availability of digital healthcare differs by country and often by region (less available in rural areas) and traditional

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institutional healthcare may be more suitable for some patient's needs.[64,65,66,67] Virtual wards, such as the UK's "Hospital at Home" programme, provide hospital-level care at home for some clinically-suitable groups such as patients with breathing difficulties or heart problems.[68-69] Clinically eligible patients have the option to choose between receiving care at home or attending traditional hospitals. The benefits of remote monitoring systems and telehealth services are to enable healthcare providers to remotely monitor older adults' health status using smart home sensors and devices,[70] wearables or smart textiles, and intervene promptly in case of emergencies or changes in health conditions.[71,72,73] This proactive approach can lead to early detection of health issues and better self-awareness and self-management of some chronic conditions.[74] Early intervention can potentially reduce the need for hospital treatment or institutional care.[75] AI-powered telehealth platforms (combining telecommunications and healthcare) facilitate virtual appointments and personalised health recommendations, aiding in self-management of conditions like diabetes or heart failure.[76]

Healthcare system technologies can also be used behind the scenes to support more effective triage and referral pathways in integrated care systems. For people who have mobility issues, assistive health technologies can support quality of life in a number of ways. Examples are a wearable GPS (Global Positioning System) falls detection watch[77] which helps reduce risks and promote mobility, and assistive robotic exoskeletons for walking support.[78] New forms of patient-centred healthcare services, like web-based health social networks[79] and personalised medicine, are empowering some individuals to self-track their health[81] and practice self-care,[82] enhancing traditional models of care.[83] For example in care cooperatives,[84] Equal Care Co-op UK uses a digital platform to create care teams that are customised for individuals.[85]

Technologies can support active lifestyle promotion and adherence to medication and treatment plans.[86,87,88] However not everyone wants to use health promoting technologies or engage in these activities.[89,90] Another important way that technologies can indirectly support health and wellness of older people is through professional education via learning technologies and networks.[91] Examples are AI-driven training

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systems for skills in pain assessment, clinical decision-making, communication, and end-of-life care. There is an extensive literature on the use of simulations, digital patients/scenarios and digital twins in professional education.[92]

Social Connection, Company and Companionship

While a digital society might isolate or marginalise some older adults, many who choose to use social engagement platforms (like Facebook or X/Twitter) and communication technologies (such as Zoom or Skype) find that these tools can facilitate social connection through virtual interactions with family, friends, and community members.[93] Such technologies can help some older adults to stay connected and engaged, reducing feelings of loneliness and depression, but only if they want to use them.[94] Advanced technologies also offers possibilities for online social engagement through virtual education and training, which can contribute to a sense of fulfilment and purpose in life.[95] Socially assistive robots are being developed and tested to support social interactions and assist with healthcare needs, including in the context of rising demand for supportive dementia care.[96,97] Companionship robots can benefit some individuals by facilitating social connections between users and carers.[98,99] The challenges are often around cost and implementation and ensuring that individuals want to use specific technologies in their lives.

Safety and Security

Technologies can support physical, financial, and emotional safety and security for some older adults ageing in place. This encompasses aspects such as technologies to support safe housing, neighbourhoods, and protection from health risks and emergencies like flooding and infectious disease. AI-powered smart home systems can play a crucial role in this regard, as they can monitor for emergencies and automate adjustments to ensure personal safety and comfort.[100]

Not everyone wants a smart home,[101] however various smart devices can be beneficial for the safety of individuals living alone, significantly reducing risks, improving emergency communications and response, as well as providing reassurance for family or caregivers between calls.[102] Technologies that support banking or financial management can bolster another type of security for older people through enabling informed decision-making, but only if individuals are able to use them.[103]

Physical Environment

In relation to the physical environment of the home, virtual reality (VR) design tools have been developed to support home safety and comfort modifications,[104] however VR tools are not always better than a home visit assessment carried out by a professional. Other technologies that assess human-building interaction can promote independence and overall satisfaction with living environments.[105] In relation to the environment beyond the home, technologies can support healthier environments by ensuring access to clean air, water, and green spaces, which positively impact wellbeing.[106] In terms of transport options, innovative AI-driven transportation planning and coordination systems offer promising opportunities for more efficient and accessible transport management.[107]

Nutrition and Food Security

Food is crucial for human health and wellbeing, yet it is often neglected in older age.[108] Digital technologies can significantly contribute to ensuring reliable access to ample, affordable, and nutritious food (called food security). Mobile applications and online platforms can provide personalised nutrition plans, dietary recommendations, and grocery delivery services tailored to the specific dietary needs and preferences of older adults.[109] Telenutrition and remote monitoring can enable

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dietitians and nutritionists to provide personalised support to larger numbers of older adults at home.[110] Additionally, digital platforms can offer access to nutrition education resources on healthy eating habits, meal preparation, and cooking techniques, empowering older individuals to make more informed food choices or build social connections around shared interests in food.[111,112]

Independence and Autonomy

Independence can foster a sense of autonomy and dignity, contributing to overall quality of life. Advanced technologies can support older adults with their independence by assisting with daily tasks or notifications such as medications reminders or mealtime reminders.[113,114] There are numerous uses of technologies for example independent self-management of health or wellbeing, facilitating access to work or volunteering, or self-managing appointments and social engagements.[115]

Spirituality and Meaningful Activities

Various smart phone apps can promote feelings of happiness, contentment, and satisfaction with life, as well as support to promote mental health, but the results depend on the apps and the individual user.[116] Online religious learning has shown benefits for relieving distress and enhancing wellbeing in some groups of older people.[117] AI-driven spiritual wellness platforms offer guided meditation, mindfulness exercises, and access to spiritual advisers, which may or may not appeal to different users.[118] AI-driven mental health support systems (not all of which are regulated or clinically approved) can provide virtual therapy sessions, mood tracking tools, and crisis intervention services.[119] Virtual reality (VR) and extended reality (XR) technologies that facilitate opportunities for leisure activities, hobbies, and cultural experiences for people who enjoy using them.[120] They can also provide opportunities for personal growth and enjoyment, such as virtual walks in nature or gallery tours, depending on the preferences of the individual user.[121]

We have briefly scanned the technology landscape and outlined the types of technologies that might enhance ageing in place experiences. Technologies have their limitations and cannot replace human experiences such as the health benefits of gardening.[122] Furthermore, it is important to have human interaction, presence and intimacy at any age.[123] There are therapeutic benefits of human-to-human direct communication and sensitive use of touch, tactile experiences, and firsthand encounters. It is paramount to use technologies to promote social connection, health and wellbeing whilst acknowledging the areas of quality of life that they cannot reach.[124,125]

The next section looks at how the policy framework might be developed in the next decade accordingly.

Policy possibilities

Advanced AI-driven and other digital technologies can enhance the quality of life for older individuals ageing in place in a wide range of ways. Policy and policymakers can guide how the technology landscape develops in a number of ways, which we outline in this section. Key facilitators will be:

- Regulatory oversight
- Equity and fairness
- Funding and investment
- Digital inclusion
- Collaboration and stakeholder engagement

Regulatory Oversight

Building on existing ethical and regulatory frameworks that have been developed internationally to regulate AI,[126,127] it is vital for further research and development work to assess the use of AI-driven technologies into the home setting. The concept of quality of life can guide future projects and programmes as a positive goal (rather than just protecting privacy, security, and informed consent). Initiatives like The Health Foundation's Tech for Better Care[128] programme

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113 *National Institute for Health and Care Excellence. 2015. NICE Guideline,* Older people independence and mental wellbeing, NG32, pp. 1-42.

114 S. Briones and L. Meijering, "Using everyday technology independently when living with forgetfulness: Experiences of older adults in Barcelona", Gerontology and Geriatric Medicine 7 (2021): 1-8.

115 Abdi, Spann, Borilovic, de Witte, and Hawley, "Understanding the Care and Support Needs of Older People."

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126 US Government Office for Science and Technology, "Blueprint for an AI Bill of Rights", (accessed July 8, 2024).

127 *European Parliament*, "EU AI Act: First Regulation on Artificial Intelligence", 2023, [accessed 09/07/2024].

128 The Health Foundation, "Tech for Better Care, A Programme Exploring the Potential for Using Technology to Enable Care at Home in the Community", (accessed July 8, 2024).

and evidence-based guidelines are positive framings, which can inspire the development, deployment, and monitoring of health and care technologies in the home space.[129,130] Policymakers can use regulatory oversight to advocate for accessibility and inclusivity, guaranteeing that all older individuals, regardless of socio-economic status, technological literacy, or willingness to engage, can benefit fairly from a digital society. Setting up collaborative forums or working groups between government agencies, healthcare providers, technology developers, and older adults and carers, could establish comprehensive regulatory standards that balance innovation with protection,[131,132] maintain quality of public services, and ensure appropriate provision for those that do not have capacity to engage digitally or with remote systems such as telehealth.[133]

Equity & Fairness

Facilitating a technology landscape that enhances older adults' quality of life must be guided by existing human rights, ethical standards, and anti-discrimination laws.[134] Fairness in a digital society could be thought of as working to ensure fair access and benefits for all groups and addressing any disparities. Ageing in place is not a straightforward issue.

Policymakers must contend with finding fair answers to the challenge of rising costs and demand for care and support, while also considering the consequences of individual's decisions to develop or abstain from using digital technologies or systems to help them stay at home. To support transparency about policy decisions policymakers can communicate with target groups (e.g., home support providers and caregivers) and explain the societal reasons behind considering technology solutions (e.g., ageing populations, workforce shortages, monitoring or early intervention). It is important for policymakers to identify and prioritise key problems, such as waiting lists for home support and waiting times in healthcare.

Targeted equity interventions, such as provision of self-management technologies for people with chronic health conditions, need to reach the right individuals for fairer outcomes that can reduce demand elsewhere in the system. The ever-shifting nature of care and support needs means it is important that the policy framework for technology

development remains flexible, responsive and has multiple feedback loops to monitor whether older people and caregivers are actually benefiting.

To address ageism, policy frameworks could promote the co-production of technology solutions specifically for ageing in place. Policy can emphasise meaningful involvement and input from diverse groups of older people and carers. Steps can be taken to prevent age-related digital marginalisation, ensuring equal opportunities for all ages to benefit from digital services and information.[135] Achieving fairness requires targeted efforts to understand and address the intersections of population, workforce and technology-related inequalities, such as urban and rural disparities in care gaps and digital connectivity.[136] Another important area to consider is fairness in the use of digital data, such as the development of age-friendly trustworthy personal data store ecosystems.[137]

Funding & Investment

Investing in technologies to facilitate aging in place could contribute to public service sustainability and economic growth[138,139] as part of a multi-faceted solution that also addresses the care gap and workforce challenges. Policymakers can consider their allocations of resources and funding to support research, development, and implementation of technology solutions for older individuals, including grants, incentives for innovation, and public-private partnerships. Financial investment could facilitate technologies for supported self-management, aimed at providing the right level and type of professional support and interventions to older adults and caregivers as their needs change.

Health and social care policymakers need to consider balanced investment in current digital healthcare systems, with investment in new technologies to mitigate barriers to participation, such as complex referral processes, scheduling difficulties, and variation in digital health literacy.[140,141] By shifting to a health promotion and wellbeing model the policy framework could enhance health and wellbeing while ensuring the sustainability of healthcare services and promoting economic prosperity. Developing a community health and support workforce capable of maximising the benefits of a digital society is essential and requires dedicated

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policy attention and investment to enable cross-sector collaborations.[142] Expanding the capabilities of the health and care workforce requires new job roles and career pathways tailored to the digital era and providing interprofessional education[143] to equip individuals with new skill sets necessary to leverage digital health tools in integrated care systems.[144,145,146]

Digital Inclusion

It is important to use research to understand the context and experience and drawbacks of the digital divide from the perspective of older age groups.[147,148] Improving access to technology and digital literacy for older individuals from diverse socioeconomic backgrounds could include subsidising internet access, providing training programmes, and promoting user-friendly technology interfaces. Policies could incentivise adoption among older adults and caregivers by showing possible enhancements in their quality of life.

Additionally, policies could advocate for freely accessible digital literacy education and training, promote the enabling role of tech ambassadors for providing opportunities for carers and caregivers to learn about technologies. Scaling existing digital education and awareness initiatives could empower more older individuals to confidently navigate digital spaces and make informed decisions online. More advanced digital literacy and skills for those who want to lean them can be developed through targeted outreach via broadcasted programmes,[149] podcasts,[150] and smart TVs.[151] Tailored internet safety schemes focusing on ageing in place are also essential so that individuals can use technologies

safely.[152] Policy can influence digital access for carers by encouraging technology designers to simplify technology setup and provide better online support and keep human diversity in mind.[153,154] Policy can address implementation challenges in home settings by encouraging human-centred design with older people,[155,156] utilising customisation and gamification to engage users,[157] offering subsidies or financing schemes.[158] Digital inclusion will become even more important for social wellbeing as populations age and technology offers practical solutions to the care gap.[159]

Collaboration and Stakeholder Engagement

Policymakers collaborating across different sectors and geographical areas should use their influence to encourage debate on inclusive innovation between public service providers, technology companies, and advocacy groups for older individuals and carers. This will ensure that the emerging technology landscape is informed by population needs and health and care provider perspectives.[160,161] More sustainable healthcare approaches capable of meeting the complex needs of an ageing population are an imperative. Expansion of virtual care for chronic conditions and age-related illnesses, as well as the provision of health and wellbeing technologies, targeted public health interventions, and enhanced access to social prescribing[162,163] and social prescribing programmes,[164] offer promise for expanding and enhancing health systems at scale and pace. All of this requires interprofessional collaboration (e.g., via UK FutureNHS Collaboration Platform), openness to discussing the pros and cons of digital technologies and understanding what matters to older people and their quality of life.

142 *Royal College of Surgeons in Ireland. 2024.* Green Paper on Home Support Workers, commissioned by Leading Healthcare Providers Skillnet, Dublin, Ireland.

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162 Social prescribing is a healthcare approach that involves linking patients with non-medical sources of support within the community to improve their overall health and wellbeing. Rather than prescribing medication or medical treatments, healthcare professionals refer patients to a range of social, cultural, or physical activities, such as exercise classes, art therapy, gardening clubs, or support groups. These activities are aimed at addressing the underlying social, emotional, or practical needs that may be contributing to a person's health issues. Social prescribing seeks to promote holistic health by addressing not just the medical symptoms but also the social determinants of health.

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Conclusion

This discussion has explored the possibilities of digital technologies to support quality of life for growing numbers of older people who are opting to age in place. The discussion provides a foundation for future policy debate on the complex challenges associated with how to provide care and support for ageing populations. Technologies and the data they generate are already playing a crucial role in supporting quality of life in older age. Expanding and enhancing these benefits in the next decade will require a policy framework that promotes greater involvement of older people and caregivers in debates, research and co-design of solutions, and co-evolution of technologies and human responses to the challenges. Key areas for future research and development are health and wellness, social engagement, safety and security, physical environment, nutrition and food security, independence and autonomy, spirituality and meaningful activities. While technologies cannot fully address all aspects of quality of life for every person they will be essential for thriving super-aged societies. Optimising the possibilities can be facilitated by policies for regulatory oversight, strategies for equity and fairness, funding and investment, digital inclusion, collaboration and stakeholder engagement.

Acknowledgements

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