Older People's Acceptance and Engagement in Emerging Health Technologies

Mengxi Zhang
Department of Science and Technology Studies
University College London

Thesis submitted to University College London
for the degree of Doctor of Philosophy
June 2024

Declaration

I, Mengxi Zhang, confirm that the work presented in my thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

The digitalisation of health technology has become an essential part of the ageing society. My thesis aims to examine older people's acceptance and participation in health technology in the context of China and the UK. Based on co-production and actor-network theory, I try to understand how health technology evolves together with the concept of ageing, older people's attitudes towards health technology and participation in the development of health technology, and the interactions of older people, caregivers, technology workers and other non-human actors in these processes. To answer these questions, I conducted semi-structured interviews and focus groups with sixty older people in China and the UK, ten caregivers and ten technology workers.

I found that firstly, older people's different perceptions of ageing are associated with varied use of health technology. Positive attitudes towards ageing generate demand for and participation in health technology, while health technology can also facilitate and quantify healthy, successful and active ageing and change older people's relationship with caregivers and other parts of society. Secondly, older people's participation in the development of health technology is limited and they have doubts about empowerment. Thirdly, in the network of various actors (older people, health technology, caregivers, technology workers and policies, etc.), older people may not have full ownership of health technology but are co-opted into the prescribed goal of the technology, subject to interference from caregivers and passively share their health data. Contextual factors can make a difference in these processes based on culture, social systems and people's trust in policies.

My thesis concludes by emphasising older people's diverse identity rather than vulnerability, cautious processing of health data and deeper consideration of the impact of health technology on equality, which helps bring the discussion back from a technology-centred perspective to the social aspects of technology acceptance.

Impact Statement

My thesis provides a comprehensive and in-depth examination of older people's acceptance and participation in emerging health technology based on STS theories. Built on actor-network theory, it firstly incorporates a multi-actor system to identify the agency and flow of social elements in older people's acceptance and participation, which is a challenge to the technocentric approach and suggests more possibilities of involving different stakeholders for technology studies in the future. Secondly, while previous studies tended to build quantitative models on the factors influencing people's acceptance of technology, my thesis tries to deeply explore the reasons behind factors and the interactions of factors using qualitative methods. Thirdly, there is a noticeable lack of research on older people's participation in technology, and my thesis has added some observations to this topic.

Outside of academia, my thesis aims to draw more attention to public health and public policy. It calls on technology workers to rethink the relationship between older people and health technology, and different stakeholders to increase equity in technology use and participation. By pointing out that the responsibilities for health technology are not yet clearly attributed, my thesis aims to bring the public attention to improve health data protection, participation in technology and relevant policies.

In addition, my thesis is a cross-cultural study. It not only adds to the missing contextual factors in other studies of older people's attitudes towards technology but will also have a range of international impacts as well as local impacts. Eastern and Western countries have long had some ignorance or misunderstandings about each other. Especially during the COVID-19

pandemic, the topics of healthcare digitalisation, digital surveillance and conspiracy theories were always debated in the international communities. The contextual comparisons created in my thesis may help develop a better understanding and communication between the UK and China.

Some of the findings of my thesis have been disseminated through publications and international conferences. I published a systematic literature review on older people's attitudes towards technology in *Public Understanding of Science*; the pilot study was presented at the EASST 2022 conference; and Chinese older people's use of the Health Code was presented at the 4S 2023 conference, through which I have exchanged insights with researchers from various countries and fields. I will also continue to disseminate the full thesis to more people to increase its impact.

Acknowledgements

I would like to express my gratitude to all those who supported me during this research. In my thesis, I describe the process of older people accepting health technology as a network, based on the actor-network theory. If my thesis is also likened to a network, it is the combination of all these supporters that successfully construct it.

First and foremost, I would like to thank my primary supervisor, Melanie Smallman. Over the past four years, I have received countless inspirations and guidance from her, which has enabled me to develop fragmented ideas into a full-written thesis. My thanks also go to my secondary supervisor, Jean-Baptiste Gouyon, for his recommendation of references, encouragement and advice.

Thanks to all my interviewees. Your ideas and opinions are an essential part of this network. Thank you for your time and candour. Particular thanks to those who organised the EIDS project – Ralitsa Hiteva and Cian O'Donovan. Without your help, I could not recruit interviewees so quickly in the UK.

Thanks also to my friends and colleagues in the UCL STS department. Every meeting and exchange made the "network" one step closer to successful construction. To my best friend who sent me a smartwatch – it made me feel more in tune with the older people I interviewed, as I really appreciated the walking reminder, but also felt kidnapped by health data.

Many thanks to my parents, who gave me the motivation to write this thesis and have always been my strongest backing during my research. Even though we are thousands of miles away from each other, I still receive plenty of love from

you. You are not only the top walkers in your social network, but also the top in my heart and my thesis network.

Finally, thanks to myself. I have always been inspired by Klara in “Klara and the Sun” on how to observe the world. Although I have not yet been able to see the world without any prejudice as she does, I have established a starting point with this thesis. Thank you for all the endeavour. “You are quite remarkable.”

Table of Contents

Table of Figures

Chapter 1: Introduction

Population ageing has become a social trend in most countries since the 21st century, because of declining fertility and an increase in life expectancy (Moreira, 2016). According to the report by the United Nations (2017), the global population aged 60 years or over has doubled in about thirty years, and the trend will even intensify in the coming decades. There is a rising trend of labelling countries with an increasing proportion of older people as “ageing societies” (Scott, 2018). At the individual level, ageing is associated with the impairment of multiple body functions, such as vision, hearing, mobility and difficulty with self-caring (Drenth-van Maanen, Wilting and Jansen, 2020). At the social level, policymakers and companies suggest that an ageing society would lead to a crisis for healthcare systems, pension schemes and the innovative capacity of economies (Peine, et al., 2015). Researchers and policies have also built various ideals of what is good ageing, which will be detailed in the literature review.

Health technology has been given great importance in ageing societies. In recent years, the continuous development of the digital industry has brought out a large number of new health technologies, including electronic health records (EHR), wearable devices, and mobile health applications (Beckers Hospital Review, 2014). These technologies are mostly based on Internet platforms and are related to big data, quantifying individual self by capturing and sharing users’ data (Rich and Miah, 2017). They enable people to have daily monitoring of their health conditions outside the hospital, thereby promising to restructure the healthcare industry. At the same time, human society attaches additional layers to health technology. Thornton, et al. (2023) find that while there is broad public support for health technologies, attitudes

towards them vary significantly by socioeconomic group. In addition to actively adopting or rejecting health technology, Barony Sanchez, et al. (2022) point out that patients and citizens can shape health technology by engaging in its development. Current policies encourage the use of health technologies and promote strategies to implement them (World Health Organisation, 2021). STS research further focuses on the complex relationships between humans and artefacts in the digitalisation of health by describing how health technology reconfigures (and is constructed by) knowledge, connectivity and control (Henwood and Marent, 2019).

Nikou, et al. (2020) indicated that health technology has increased capabilities for independent living, which is especially important for older people (also referred to in the following as "older adults" or "the elderly"[1]). Although science and technology are often considered as "solutions" to solve these challenges (Moreira, 2016, p.5), the ageing population can also be seen differently rather than as a social burden and older people are not just passive recipients of technology. With a sociological approach to ageing and technology, Joyce and Loe (2010) noted that older people can creatively utilise and reject technology, which challenges the technology-centred discourses. Lupton (2013) describes patients' use of digital health technology for self-care and monitoring as empowerment, in which people are more in control of their bodies.

Some early reports on technology and ageing society focused on the contributions and advantages of health technologies (i.e., technology's role as "solutions"). Lindeman (2012) believed that health technology can increase people's understanding of health through diagnostics, communications and

[1] "The elderly" is considered as ageist language and I will avoid using it, but the term still exists in some other literature and in citations.

health informatics. The automation of technology is also seen to save labour costs and make personalised healthcare possible (Thimbleby, 2013). As for older adults, more digital health technologies that emerged in recent years are claimed to help make life easier. For example, Loe (2010) introduced how older women in New York creatively used technological tools to care for themselves and achieve self-efficacy. She found that health monitoring had created a sense of security for older people by helping them keep in touch with friends and maintain social relationships. Brittain, et al. (2010) argued that technologies could support or hinder access to some outdoor places for older people with dementia in case they get lost and anxious. The World Health Organization (2015, p.110) has summarised these contributions in its report on ageing and health as health technologies can "help older people remain healthy, active and independent as long as possible".

Despite the above "advantages", older people's interest in and use of health technologies is found to be much lower than that of other age groups, and this proportion also decreases with age (AXA PPP, 2015; Gordon and Hornbrook, 2016; Wang and Qi, 2021). Eubanks (2018) points out the reinforcement of inequality by technology, which makes the situation of marginalised groups even more difficult. Smallman (2022) proposes a Multiscale Ethics Framework of artificial intelligence (AI) in healthcare and indicates that technology can produce inequality on the individual dimension to the globe and even cause serious social damage such as discrimination and extremism. Not only does this refute the technological-advantaged standpoint of the above literature, but it also raises questions about whether older people's lack of acceptance of health technology is also related to inequalities.

Existing literature has already found that older people experience downsides of health technology and there are potential inequalities in technology acceptance caused by access, digital skills, conflicts among stakeholders, values and trust. Evidence shows that older people have less access to the Internet than the young and middle-aged population because of a lack of means and motivation (Peacock and Künemund, 2007). Although older people's access has increased in recent years, there is a possibility that "former onliners might become offliners due to physical limitations (like eyesight deterioration)" (Friemel, 2016). This disparity in infrastructure can lead to potentially lower coverage of health technology for older people than for younger people, deepening health disparities among different age groups (Viswanath and Kreuter, 2007). For older people who use health technology, there are age-related or technology-related downsides that hamper their use, such as cognitive decline or an unreadable interface, which give them a feeling of inadequacy (Vaportzis, Giatsi Clausen and Gow, 2017). There are also conflicts of interest between older users and other stakeholders (such as doctors, caregivers and health insurance staff) that influence older people's use of health technologies (Vaziri, et al., 2019). This paper shows that the two groups of stakeholders are contradictory in whether technology should improve health literacy (as health professionals may worry about older people's resistance to their advice because of misinformation provided by emerging technologies) and provide reminders (as users may get annoyed but caregivers would find it helpful in reducing caring responsibilities). When the interests of older people are overridden by other stakeholders, they may withdraw from using health technologies. A more frequently mentioned conflict is data privacy (Yusif, Soar and Hafeez-Baig, 2016; Fox and Connolly, 2018; Vaziri, et al., 2019). Research found that older people are afraid of the leakage and abuse of private data, but technology companies and insurance agencies are the promoters of data

collection to make profits. Moreover, Ware, et al. (2017) argue that older people are sceptical about the credibility and ownership of health information provided by health technologies. Lie, Lindsay and Brittain (2016) indicate that older people's acceptance of technology is also linked to trust in the safety at home, caregivers, service providers and even the government, while health technology may sometimes undermine the trust. In addition, public participation is a response to people's distrust of science (Wilsdon and Willis, 2004), and older people's participation in technology is found to be at a lower level than other age groups (Fischer, Peine and Östlund, 2020).

Coleman, et al. (2010) raised the possibility that people attribute the digital exclusion to the generation gap rather than age, as young people of this era are surrounded by various technologies during their growth and the technological gap will disappear when they become older. However, considering the continuous and rapid development of technology over time, and the commonalities that come with ageing, the technological aptitude of the current cohort of young people is no safeguard against digital exclusion and inequalities in later life (Neves and Mead, 2021). Therefore, it is meaningful to investigate older people's attitudes towards health technologies (or even "older people" of different ages).

During the COVID-19 pandemic, the pattern of older people's adoption of health technologies changed. As access to most of the regular healthcare (non-COVID) services is interrupted during the pandemic, telemedicine and digital healthcare are promoted (Martins Van Jaarsveld, 2020). Statistics show a big increase in the proportion using the Internet and digital technologies (for the first time) in the 65-74 age group (Tabassum, 2020). Existing research tends to emphasise the positive role of health technologies for older people during the COVID-19

pandemic, such as closing the gap in healthcare (Martins Van Jaarsveld, 2020; Bhatia, 2020) and mitigating loneliness (Conroy, et al., 2020), but inaccessibility, distrust and inequalities in health technology may remain or even increase because of limited offline services. Whether older people accept health technology equally or are at risk of increased social isolation in the pandemic needs further research.

Differences in the acceptance of health technology exist not only between older and younger people but maybe also between older people living in different countries. Li and Kirkup (2007) compare the Internet use of students in China and the United Kingdom (UK) and find that British students use the Internet more than Chinese students. Su and Li (2010) indicated that Chinese people worried more about the use of mobile phones than British people. These articles attribute the differences to the availability of access, technology education and ideology (collectivism or individualism) in the two countries. Considering the acceptance of health technology, Luchenski, et al. (2013) and Sauchelli, et al. (2023) note that British people are generally open and supportive of health technology, with concerns about security and data privacy. A study on Chinese acceptance of health technology shows that people have a modest acceptance of wearable devices and high expectations for health management functions (Wen, Zhang and Lei, 2017). Chinese older people also reported confusion about mobile health technology and a sense of dependence and burden because of the need for help (Tu, et al., 2021). The above literature potentially demonstrates that British people may have more positive attitudes towards health technology than Chinese people, but no literature is found specifically comparing them and exploring the reasons for the differences. During the COVID-19 pandemic, trust played a great role in the acceptance of health technology. Dowthwaite, et al. (2022) confirm that trust in government,

technology companies and the healthcare system can influence the adoption of contact tracing apps. Compared with the policy discourse of deliberative democracy and heightened interest in the public engagement in the UK (Pieczka and Escobar, 2013), China has been promoting national science literacy particularly since the 21st century as part of its all-round development strategy (Liu, Tang and Bauer, 2012). National surveys show that Chinese people's participation in science and technology affairs is much less than that of European countries, which may be related to different focuses of science policy and democratic nature in China and the UK (He, Zhang and Gao, 2008; He, et al., 2018). Based on the above points, China and the UK can be compared in public attitudes towards technology and participation, and it is worth filling the gap of differences in older people's attitudes towards health technology between the two countries based on differences in accessibility, ideology, values, trust and policies.

I have already introduced some pros and cons of health technology for older adults but there seems to be a lack of knowledge of older people's acceptance of health technology from multiple perspectives with sociology theories and a lack of exploration of how inequalities are created. I use the term "acceptance" instead of "adoption" or "use" in my thesis because acceptance does not necessarily lead to adoption but encompasses a wider range of attitudes and perceptions (such as older people's views on the public using health technologies). Enlightened by the idea of co-production and the actor-network theory (ANT) (which will be introduced in the literature review) and building on what is known about older people's attitudes towards health technologies, my thesis tries to discover how ageing and ageing society is co-produced with health technology and how key actors (e.g., caregivers, technology workers, technology, health data) play their roles in the network of older people accepting

and participating in health technology. From this, I hope to fill the academic gap of sociological observation of groups related to older people, enhance the connection between technology development and older adults who are often excluded in the discourse of technology and improve older people's voices in science and technology communication.

Chapter 2: Literature Review

2.1 Science, technology and the ageing society

The relationship between science, technology and society is dynamic and has long been discussed. When we look back at the development of Science and Technology Studies, we see different theories or perspectives on this issue: believing that technology can determine social events, emphasising the social shaping of science and technology, and focussing on the co-production of science and society. These relationships have been supported by research of different eras. For my research on people's acceptance of a certain kind of technology, visiting and illustrating the multiple relations is a fundamental and non-ignorable theoretical work.

Technological determinism

In the views of the relationship between science, technology and society, one of the most influential theories is "technological determinism". It considers technology as an individual item with its own developmental sequence to impose certain effects on society (Heilbroner,1967). Technologies (or machines) are like background elements in the narratives of history-writing and could "make history by changing the material conditions of human existence" (Heilbroner, 1994).

By labelling this statement as the "Logical Sequence Account" of technological determinism, Bimber (1990) pointed out the strong claim it made to link technology with social change, which is independent of cultural factors. As there are real examples indicating that people could sometimes feel powerless to shape or resist the internal model of technology, the theory of technological

determinism was once apparently accepted by the public and some historians of technology (Ceruzzi, 2005).

The social shaping of technology

Although human activities are driven by technology to some extent, more scholars have opposed technological determinism by arguing it removes the vital aspect of our political life and social forces on the direction of technological change (MacKenzie and Wajcman, 1999; Russell and Williams, 2002). These scholars rather emphasised the social shaping of technology and considered technology as a "system" with economic, organisational and cultural aspects. It implies that society plays a significant role in determining the development and impact of technology and encourages people to analyse technology within its contexts.

According to this statement, the innovation process involves different alliances of interests – supplier firms, technologists, users and regulators are all components of the society to actively form an interactive and spiralling technological development model from generation, production, widespread use to reconfiguration and implementation of new technologies (Williams and Edge, 1996). Mackay and Gillespie (1992) specified the significant role of marketing to inform the design and construct demands for technologies in the process; and social appropriation in which people perform as creative subjects to even invest idiosyncratic symbolic meanings in technologies.

There has been extensive literature on the use of this theory. For example, Lievrouw (2006) described how new media technologies develop in dynamic social environments and emphasised the importance of human choices and actions. One of the specific examples she gave was that the popularity of

informal use of e-mail was caused by the privatisation of the Internet and people's establishment of consensual rules. Bibri (2022) discussed the imaginaries of the Metaverse using the social shaping of technology as a framework. He criticised the discourse of Metaverse as deterministic and argued that the trend towards virtualised life was amplified during the COVID-19 pandemic and the promotion of the development of Metaverse stemmed from the quest of technology companies for economic gains, industrial competitiveness and political power. Based on these studies, I will use the social shaping of technology in my thesis to find out how human and social environments may shape health technology, including people's creative use of health technology, the deployment of health technology by social policies and the transformation of the health technology system during the COVID-19 pandemic.

Co-production of science and society

Jasanoff (2004) further developed the idiom of "co-production" in her book "States of Knowledge", arguing that conversations and ideas about science and technologies evolve together with the way in which people choose to live in the world (both nature and society). This idea gives a two-way explanation to the relationship between technology and society, that is, when we produce technologies, the process reflects the world we want to live in, and the technologies also produce new social orders. It is a loopback to unite the roles of technology and society, which extends the statement of the unidirectional influences of society on technology in the social shaping of technology.

Jasanoff (2004, pp.39-41) recognised four common instruments of co-production: making identities, making institutions, making discourses and making representations. They can be explained succinctly as identities can be

redefined or maintained under negotiation with the evolvement of technology; new laws and standards are born out of technological development, technology and new languages are evolving together for new orders, and components of society can interact with representational practices in science. All of these instruments can help give practical and visualised interpretations of co-production from the societal stand.

Based on the idea of co-production, Pickersgill (2012) illustrated the “loopback relationship” between neuroscience and ethics – people “create” certain ethical issues when producing knowledge about neuroscience, and it engenders regimes of normativity about the workings of neuroscience. Jasanoff and Simmet (2017) applied the idea of co-production when criticising the framing of post-trust. They suggested that instead of believing truth has been cast aside in the public sphere, we should be aware of how truths are produced in politics that people desire and practice and have the normative force. An example of health technology shows the development of digital health is related to human’s imagination of telemedicine and social connectivity and digital health may empower patients from a sociological perspective (Kivits, 2013).

In addition, Parthasarathy (2015) explained the biotech patent controversies in Europe and the US from a co-productionist lens. She argued that the US patent system is driven by market efficiency and social benefit without consideration of ethics, privileging knowledge and laws, which were in turn used to develop market rules; the European patent system has rather prioritised the possible harm of subjecting innovations to market and the allocation of responsibility, resulting in growing scrutiny of patents and the exclusion of human embryonic stem cells (hESCs) from patentability.

These illustrations of co-production will help me to further understand the interactions between health technology and the ageing society. I will explore how certain ideas of the ageing society work in producing and shaping health technology, and how health technology reshapes older people's identity, change social rules and create new discourses about ageing. I will also compare how decisions about health technology are created in the choice of social backgrounds (especially the ethical considerations) and shape different societies between China and the UK.

Actor-network theory

The actor-network theory (ANT), originally developed by a group of researchers in the 1980s, splits "science", "technology" and "society" into smaller network components. ANT emphasises the materiality of actors in the whole network and defines the technology and social objects by their places and relations in the network (Law, 1999). In these network systems, human and non-human actors are equally driven by interests and work through the "translation" of material actions, which means that concepts and interests are negotiated and stabilised among diverse actors, with "consent to detour and displacement" (Callon, 1984; 1986; Latour, 1987; 2007; Sismondo, 2010, pp.81-87). That is, successful translation is a process of constant reconfiguration and compromise of concepts and interests, such as the conversion of entities into inscriptions (e.g., documents, survey results) (Callon, 1984, pp. 26-28). One of the major novelties of ANT is that it treats non-human entities (e.g., technologies, artefacts, and objects correlated with technological configurations) as actors with the "agency" to shape social relations and practices. They are not subject to human manipulation but rather have the same capacities and power (which are subsumed in the notion of "agency") as humans to form networks.

In recent decades of ANT's development and evolvement, scholars have focused on different approaches, including a theoretical discussion with social science and the characteristics of ANT's tools (Baron and Gomez, 2016). For example, when introducing ANT, Latour (2007) brings "uncertainty" into social theory. He argues that groups are formed with uncertainty and controversy so we should trace the actors (who can speak for the group) and the motivations for them to take action in the changes of the group; and the action and agency of objects are also a form of establishing uncertain connections. Law (2008) highlights the importance of ANT working in practice, in which there is heterogeneity, materiality and semiotic relationality – different and aplenty elements shape one another in the network; and it is the configuration of the network rather than materials that produce durability. These studies prompt me to view the acceptance of health technology as uncertain networks with different actors and focus on the roles of actors in configuring the network and their "translations".

ANT has also received many criticisms over the years in which it has been proposed. For example, Clark (2019) argued that according to its "relational onto-epistemology" (the translation), the study of non-humans will centre on the entanglements of humans and non-humans, while the agency of non-humans (without humans' inquiries) is sacrificed (e.g., their resistance to humans' enrolment). Marres (2019) took inspiration from pragmatism and suggested three undoings of ANT which it claimed to have put to rest, including returns to interpretation, society and epistemology. This article reflected the possible limitations of ANT in interpreting bias, labelling social concepts and discussing knowledge claims. Therefore, I will use ANT as an approach from a critical perspective and discuss new insights that emerge from the collision of ANT and

the topic of health technology acceptance, stepping out of the rigid framework of ANT where needed.

Older people and the ideals of ageing

There is no consistent definition of "older people". The United Nations (2017) refers to "older people" as those over the age of 60 for statistical purposes, and many countries also recognise 60 as the starting value of old age, such as China[2]. In developed countries including the UK, "older people" are sometimes indicated as people over 65[3], while some least developed regions use a lower age to mark the start of later life because people there have lower life expectancy and experience functional decline much earlier than in developed countries (Sagner, Kowal and Dowd, 2002). In addition to nationality, the identity of older people may also correlate with health status (e.g., loss of vision and hearing, as mentioned in the introduction chapter) and role losses (e.g., retirement, having an empty nest and a need for care) (Westerhof, Barrett and Steverink, 2003). This shows that ageing is a social construction rather than a natural process.

Bordone, Arpino and Rosina (2020) investigated the factors influencing older people's perceptions of ageing and found that they commonly reported decreasing physical health and loneliness as reasons for feeling old. They also identified that older people tended to declare not feeling old to maintain a younger identity, which reflects their avoidance of negative stereotypes of ageing. Cuddy, Norton and Fiske (2005) pointed out that older people are often stereotyped as warm and incompetent, which triggers emotional prejudice of pity, and this seems to be consistent across East Asian and Western countries.

[2] See the Law on Protection of the Rights and Interests of the Elderly: https://www.lawinfochina.com/display.aspx?id=12566&lib=law

[3] An example on the NHS website: https://www.england.nhs.uk/ourwork/clinical-policy/older-people/improving-care-for-older-people/

However, older people's own perceptions of ageing may differ between China and the UK. Warmoth, et al. (2018) argued that compared with China, people in the UK have more negative views towards ageing and old age is associated with low social status and frailty in European countries. Lu, Kao and Hsieh (2010) confirmed that older people in Chinese society have generally positive attitudes towards ageing, but a lack of social support and community participation would lead to negative attitudes towards ageing. A UK report identified that people aged 50-69 had the most negative attitude towards ageing, as they link ageing to overstretch from working and caring responsibilities; but people over 70 are rather positive towards ageing, focusing more on what they still had instead of what they have lost (Centre for Ageing Better, 2021). My research will further compare the perceptions of ageing in the two countries and discuss their relationship with health technology acceptance.

Existing literature has established different ideals about ageing to challenge the stereotypes of older people, including healthy ageing, successful ageing and active ageing (Lin, et al., 2022). To be specific, health ageing refers to the process of developing and maintaining functional ability in older age, which requires extensive care for older people (World Health Organization, 2015; Rudnicka, et al., 2020). Successful ageing was defined by Rowe and Kahn (1997) as a low probability of disease and disability, high cognitive and physical function, and engagement with life. It is an advanced vision of "healthy ageing" as in addition to the basic health demands, it encompasses the autonomy of older people, their ability to control their personal environment, their need for social interactions and personal development, etc. (Depp and Jeste, 2006). Active ageing refers to "the process of optimising opportunities for health, participation, and security in order to enhance the quality of life as people age" (WHO, 2022). Its focus on "participation" goes further than the need for social

relationships and social activities in the concept of “successful ageing”. These ideals provide frameworks for ageing policies, but Stephens, Breheny and Mansvelt (2014) suggested that older people have more detailed claims or adjustments to these frameworks, such as compromises in maintaining health and socialisation because of limited finances. This exemplifies the discrepancy that exists between the ideals of ageing and older people’s actual expectations. My research will further explore older people’s perspectives on ageing (with perceptions of health technology) and how they apply to these frameworks.

The ageing society and technology: how does the relationship fit into the above STS theories and what is special for the ageing society?

The ageing trend was once regarded as a demographic “problem” or “challenge”, as people see it brought many downsides to society and the economy, such as declining productivity, increased burden of healthcare sectors and increase in dependency ratio (Restrepo and Rozental, 1994; Borji, 2016). The literature then focused more on what to do to remain healthy and active in later life (Walker, 2002; Cattan, et al., 2005) in order to reduce the crisis caused by the “problem”, and science and technology are regarded as the means to solve the problem (e.g., Helbostad, et al., 2017), which underpins the idea of technological determinism.

In recent years, the relationship between science, technology and the ageing society has transformed. Rather than emphasising the unidirectional impact of technology on human life experiences and practice, STS research focuses on the possibilities and challenges that the ageing society could bring to technology. For example, as older people are often classified as the non-primary labour force with a decline in personal savings and higher demand for the pension system, population ageing is likely to have a negative effect on

economic growth (Ince Yenilmez, 2015). This economic circumstance does not seem to be conducive to the adoption of new technologies. Similar assumptions also include that older people are more vulnerable and culturally conservative, which might increase the difficulty of technological innovation for them (Sponselee, et al., 2007). However, population ageing also has positive impacts on technology and innovation. Compared with the past, the economic and health situation of older people has improved greatly with a large share of fixed assets (Légaré, 2015). By treating older people as a societal resource rather than a burden, Olshansky, Beard and Börsch-Supan (2012) believe that investment in health and longevity could inspire technological innovation. In this sense, older people can be both the users and the promoters of innovation. Researchers have then developed a focus on the relationship between older individuals and technology, investigating older people's attitudes and participation in technology, which will be specifically addressed in later sections.

Lievrouw (2014) introduces the mutually determined relationship among artefacts, practices and arrangements. She argues that while material devices can enhance or constrain people's abilities and change practices through a process of reconfiguration, social arrangements could also reform artefacts and practices during the development, which creates a dynamic feedback loop. As for the ageing society, Moreira (2016, pp.22, 26-28) encapsulates a "wave model" of how older people, technology and the social system interact, indicating that technology is characterised by various phases of social and economic organisation and the changing socio-technical conditions would also affect people's ageing process. The "wave model" can then become an echo of "co-production" and ANT in the context of the ageing society and it encourages me to further explore the co-production of the concepts of ageing and technologies.

In the last two decades, besides older adults who are not generally considered tech-savvy (Wallace, Graham and Saraceno, 2013), some research identified that there are subgroups of “silver surfers” who often “became familiar with computers at an early stage of work”, have similar adoption patterns with younger adults, but different experiences and needs (Olson, et al., 2011; Olsson and Viscovi, 2020). With the popularisation of new technologies and changes in the social environment, this group of people might become larger, which leads to further attention to the diversity of older people and their interactions with technology in various socioeconomic and cultural contexts.

The above literature shows that the roles of older people and technology are both unfixed, and they can shape each other considering the existing power structure, societal transformations and geographical and cultural factors. Enlighted by ANT, I will further analyse the agency of older people, technology and all these factors in networks, avoiding exaggerating or ignoring the role of any actors. My thesis is grounded on these theories to explore how older people think of and shape health technology, how health technology affects older people and changes the ageing society, and how various actors play a role in the network under certain social and cultural contexts.

2.2 What factors influence the acceptance of technology?

To examine older people’s acceptance of health technology, I first visited literature about public attitudes towards science and technology (S&T). This section starts by describing the development of academic investigations in public attitudes towards S&T, from the “science literacy” paradigm to the public understanding of science. Then through a review of extensive literature on

public attitudes towards diverse types of technologies, I can present how technology influences people and how people perceive technology.

Research development of public attitudes towards S&T

Researchers have conducted surveys on the public attitudes towards science and technology (S&T) for more than 50 years, with measurements including people's views on the contribution that S&T makes to society and their willingness to fund S&T (Besley, 2013). Pion and Lipsey (1981) analysed national opinion polls from the 1950s to 1970s in the US and found that a large majority believed that "science and technology have been a positive benefit", but the public's conception of S&T was somewhat vague based on varying levels of exposure. Bauer (2008) labelled the survey research of this period as a "scientific literacy" paradigm, which fixated on the cognitive deficit of the public.

In the late 1980s, researchers began to pay more attention to public understanding of science (PUS) and the attitudinal deficit. People began to show more belief in the promise of S&T and more concern about their impact (Miller, 2004; National Science Board, 2000). Although there were high levels of public interest in S&T, researchers tended to believe that the public was still not well-informed and lacked scientific knowledge (Durant, Evans and Thomas, 1989). It was known as the "deficit model", which means that the lack of public knowledge may lead to scepticism toward science (Sturgis and Allum, 2004). Conversely, it was assumed that better-informed people could have more positive attitudes and support for S&T.

However, technologies are not good for all people, and people's attitudes towards S&T and the adoption or rejection of technology are affected by various factors. By searching the keywords "attitudes/acceptance/adoption" and

"technology" in several literature databases (including SCOPUS, Web of Science and ProQuest), I obtained hundreds of articles suggesting possible influencing factors, which can be categorised into three groups – factors mainly related to users (or personal factors), factors related to technology (technological factors), and social contexts behind the interaction between humans and technology (social and contextual factors). The framework is also used in other studies of people's attitudes and adoption of technology (e.g., Cajita, et al., 2018; Dequanter, et al., 2022).

Personal factors influencing technology acceptance

The factors related to users first include sociodemographic variables, such as gender, age, education level, income and occupation. There have been many studies on gender or age preferences in technology acceptance and adoption. As early as in the 1980s and 1990s, scholars investigated young people's gender differences in computer attitudes and found males had greater exposure to computers and more positive attitudes and confidence with computers than females (Chen, 1986; Shashaani, 1994). Kotze, Anderson and Summerfield (2016) also found that women were less optimistic than men in adopting high-technology products with higher levels of risk aversion. In terms of age differences, evidence shows that young individuals use technologies more frequently and tend to have more positive attitudes towards technologies than older adults (Edison and Geissler, 2003; Czaja, et al., 2006).

Low level of education and income was proved to be possible barriers to the adoption of technology. Abu-Shanab (2011) found that a higher level of education could enhance people's control over technology and help to achieve better performance. In the workplace, there is also a positive correlation between education level and the adoption of technologies for higher-order tasks

(Riddell and Song, 2017). Research attributed the impact of income level on technology adoption to the issue of the “digital divide”, which indicated that developed countries and high-income people had more opportunities to use technology and it would reinforce economic inequality (Van Dijk, 2006; Zhang, 2013). Although low-income people began to use smartphones more in recent years, this gap still exists (Anderson and Kumar, 2019). The occupational category was less mentioned integrally as an influencing factor of technology adoption due to its complexity, but Vishwanath and Goldhaber (2003) implied that there would be more adoption if the new technology could be useful in the job.

It is important to note that none of the above factors should be a single determinant, as males and young people may generally have higher levels of education, income and more social resources. For example, literature pointed out that women adopt agricultural technology less often than men due to their lack of wealth, labour, education and connections with suppliers (Doss and Morris, 2000; Göransson and Rolfstam, 2013). Age and gender differences in technology acceptance are also because the design of the technology itself is not neutral, with attributes pre-set by technicians and corresponding cultural presuppositions. For example, Perez (2019) confirmed the gender gap in technical data and design by pointing out that cars, smartphones, voice recognition and some AI products are male-biased, and women are prone to feel uncomfortable or report errors when using these technologies. Miller, et al. (2021) found many facets of smartphone use are age-related and exclude older people. Older people did not think the icons on the screen (mostly designed by young people) were “intuitive” and would even feel less confident and frightened of making mistakes. Moreover, Winner (1980) gave a famous example that established the account of the political nature of technology, that is, the low-

clearance bridges over the parkways on Long Island were designed with bias to limit the access of racial minorities and low-income groups who normally took tall buses. Different races and classes are separated by values embedded in technology (Miller, 2021). These biases inherent in technologies may further widen the gender, age, educational and racial gap.

In addition to the sociodemographic variables, the individual's past user experiences, media use and value predispositions were also mentioned in literature as possible reasons affecting technology adoption. User experience (UX) includes the emotions, preferences, perceptions and behaviours before, during and after the use of technology, which has great importance in long-term decisions of technology adoption and evolves over time resulting in advanced expectations (Hakkarainen, 2013). The influence of mass media on technology adoption was mainly explained by the paradigm of "diffusion of innovation" in communication studies, to emphasise innovators' adeptness in using media to get information about technological products and their tolerance for novelty (Rogers, 1995; Vishwanath and Goldhaber, 2003). For the general public, positive news frames could enhance their support for technologies (Besley and Shanahan, 2005; Ho, Brossard and Scheufele, 2008). The latter article also mentioned the role of value predisposition when making judgments about technology. It was said that those who are liberals, show low levels of religiosity or high deference to scientific authority would be more supportive of technological research and more influenced by knowledge than those of low deference.

Technological factors influencing acceptance

Technological factors mainly involve access, cost, usefulness, ease of use, innovativeness, credibility and security. It is worth noting that although these

factors seem to be related to technology, they are closely bound up with the user's own situation, as the cost of technology actually refers to the user's consideration of cost, and the usefulness and ease of use are usually expressed as the "perceived usefulness" and "perceived ease of use" (of the users).

Access is the basis for the association between people and technology, and at least Internet access is required for emerging digital technologies. It was estimated that a total of 3.7 billion people in the world do not have Internet access, most of whom are from underdeveloped countries (UNESCO, 2019). This has led to essential inequities in digital literacy and skills for these populations. The lack of access also reflects and widens the issue of imbalanced power, disenfranchisement and maldistribution of benefits (Bozeman, Slade and Hirsch, 2011).

The impact of cost on technology adoption has been studied on a variety of technologies, such as agricultural technologies (Mwangi and Kariuki, 2015) and aquacultural technologies (Kumar, Engle and Tucker, 2018) which require large-scale investment, as well as small digital devices whose adoption are mostly based on personal decisions (Hanafizadeh, et al., 2014; Park, 2020). The costs in these articles are related to transactions, transportation, training, fixing and purchasing accessories. Mwangi and Kariuki (2015) and Park (2020) also mentioned that people would compare the benefits of the technology with the costs in making decisions. However, for small digital technologies like wearable devices, Park (ibid) shows that the effect of costs on adoption was relatively weak. This may be because, with the popularisation of smartphones, people who already own related devices tend to ignore the initial economic hindrances.

Usefulness, ease of use, innovativeness, credibility and security are determinants often included in quantitative research and acceptance models, such as the technology acceptance model (TAM) and technology readiness index (TRI). TAM was first developed to predict user acceptance of computer systems, whose fundamental determinants are perceived usefulness and perceived ease of use, and usefulness has a stronger influence on usage than ease of use (Davis, 1989). After that, TAM was further developed into TAM2 and TAM3, in which scholars added the effect of subjective norm, image, job relevance, output quality, etc. on perceived usefulness (Venkatesh and Davis, 2000) and computer self-efficacy, anxiety and playfulness as the predictors of perceived ease of use (Venkatesh and Bala, 2008). Venkatesh, et al. (2003) proposed the unified theory of acceptance and use of technology (UTAUT) on the basis of eight relevant models, in which the perceived usefulness, relative advantage and outcome expectations that have overlapping interpretations in different models were integrated into “performance expectancy” and (more) perceived ease of use was expressed as (less) “effort expectancy”. Besides, social influence (which will be detailed in the next section) and facilitating conditions (e.g., compatibility) were also set as core determinants of technology acceptance in UTAUT. UTAUT was further extended to UTAUT2 with the addition of “hedonic motivation” (the fun or pleasure derived from using a technoloigy) (Venkatesh, Thong and Xu, 2012). TRI is to measure the degree to which people are inclined to use new technologies “for accomplishing goals in home life and at work”, comprising four dimensions of optimism, innovativeness, discomfort and insecurity (Parasuraman, 2000; Parasuraman and Colby, 2015).

The models and indexes above are usually constructed with technology at the centre and have some similar indicators, most of which are claimed to be positively correlated with technology acceptance, to enlighten technologists about which aspects of the technology can be improved. For example, it is assumed by TAM and UTAUT that technologies are better accepted when they are more useful (or have higher performance expectancy) and are easier to use (or need less effort). Over the last two decades, these models have been applied by numerous literatures from different countries and in different domains. To name just a few, Teo, Luan and Sing (2008) found that TAM can be used to explain the acceptance of technology among pre-service teachers in Singapore and Malaysia; Chao (2019) applied the UTAUT Model to analyse the factors determining the intention to use mobile learning and confirmed that performance expectancy and effort expectancy both have a significant impact on technology acceptance. Many studies have also extended these models in specific fields or elucidated their limitations. For example, it was said that perceived security and privacy risks may have a significant impact on the acceptance of online banking services and health technologies (Giovanis, Binioris and Polychronopoulos, 2012; Alsyouf, et al., 2023). McCoy, Galletta and King (2007) emphasised the need for caution when applying TAM across cultures, because cultural factors such as masculinity, uncertainty avoidance and collectivism may nullify the effects of technological factors. Therefore, it is not enough to consider only the technological aspects when we analyse public acceptance of technology. The next section brings broader social factors into the picture.

Social and contextual factors

Broader organisational context and social change processes should be taken into consideration to explain the acceptance of technology (Legris, Ingham and

Collerette, 2003). First of all, the social factors closely connected with individuals are peers and networks. In TAM2 and UTAUT, the determinant "social influence" covers the items of "people's perception that important people to them think that they should use the technology" and "adopting the technology would enhance one's status in the social system", which take the individual as the starting point (Venkatesh and Davis, 2000; Venkatesh, et al., 2003). There are also "adoption following, or rejection influenced by surrounding people" (Talukder, 2012) and "whether the overall situation supports the use of technology" (Kamin, Beyer and Lang, 2020) that can be categorised as "social influence".

There are also conflicts of interest in technology adoption, which take place among users, suppliers and third-party organisations. For example, Elmustapha, Hoppe and Bressers (2018) analysed the contrasting priorities among various stakeholders in the adoption of solar energy technology, as end users mainly focused on the economic benefits brought by technology and social interaction (positive word of mouth and low-cost marketing), while suppliers hope to obtain higher market performance. Studies on the adoption of social platforms, e-commerce and mobile payment systems involve the conflicts of data and privacy, as users tend to keep their personal information and digital footprints, but technology companies want to collect user information and track activities and locations for targeted services (Au and Kauffman, 2008; Boritz and No, 2011). Eubanks (2007a; b) demonstrated some concerns of low-income women about technology, as they were likely to be subject to intense technologically mediated surveillance via technologies and lose jobs due to technological change and worker deskilling. New technology and conflicting interests gave them an exploitative and intrusive experience rather than fair distribution.

STS research suggested that attitudes towards technology can also be influenced by ethics, trust in government and the commercial context of the technology. For example, Sample, et al. (2020) found that the public has ethical concerns about brain-computer interface (BCI) technologies in terms of agent and consequence, including redefining humanity, changing identities and new forms of hacking. Guan and Chen (2023) analysed public discussions on facial recognition technology (FRT) in China and observed that in addition to privacy concerns, the public also demonstrated a dependence on the state and political authorities to take responsibility for governing FRT and that trust in the government and the social atmosphere of valuing technology can create positive public attitudes towards FRT. Walshe, et al. (2024) indicated that many studies have shown that the commerciality of the organisation, benefit sharing and ownership of data are important factors for the public to consider biobank participation and genomic data sharing.

Technology acceptance also varies among people in different countries because of demographics, economy and culture. The impact of demographic variables and the cost of technology on attitudes can be expanded to the national level, as evidenced by a comparison between Ecuador and Russia (Cruz-Cárdenas, et al., 2019) and the relationship between economic status, infrastructure development and technology adoption in Sub-Saharan Africa (Oke, et al., 2014). More literature explored the link between culture and attitudes towards technology. For example, McCoy, Galletta and King (2007) found that high collectivism would lead to less focus on individual effort and more attention to others, and thus people from highly collective countries (refer to some Latin American countries in this article such as Colombia and Venezuela) may care less about the ease of use of technology and more about

the benefits of technology acceptance for others. Lee, Trimi and Kim (2013) investigated cultural differences in mobile phone adoption patterns between the United States and South Korea, noting that Americans are more influenced by the innovation effect, while mobile phone adoption in South Korea has a higher imitation effect. In addition, Miller, et al. (2021) implied that the use of digital devices in some countries might be a political requirement to form a unified and productive civil society, but this point of view needs further investigation.

2.3 What do we already know about older people's attitudes towards technology?

For older people and the ageing society, some of the factors described above are reinforced, some may no longer be determinants or have not yet been covered by research, and there are also new factors only applying to older people. This section will build on this to review the factors influencing older people's attitudes towards technology. The literature was searched with the keywords of "older people/adults", "technology" and "attitudes/perceptions" in the same databases (SCOPUS, Web of Science and ProQuest).

Factors that also affect older people

Most factors are still crucial in affecting older people's attitudes or adoption of technology, including sociodemographic variables, access and cost, perceived ease of use and usefulness, perceived security and data considerations, and conflicts between stakeholders.

Some studies further divided older people by age and found that "older seniors" are significantly less willing to embrace technology than "younger seniors" (Ma, Chan and Chen, 2016). This is consistent with the comparison between

younger and older adults and is attributed to declining health and conservatism that continues with age (Pirhonen, et al., 2020; Safarov, 2021). Older men were found to be more likely than women to use mobile phones and computers, while older women tend to use assistive devices more than men (Pan and Jordan-Marsh, 2010; Seifert A and Schelling, 2015; Hong, 2016). It is speculated that this might be related to the social image of gender, as men were more likely to be endowed with the role of “workers” (using instrumental technology) even if retired and women were perceived to be dependent, in the roles of wives and mothers (Arber, et al., 2008). Older people who are less educated are not as engaged digitally as their well-educated counterparts due to differences in understanding and accessing technology (Vulpe and Ilinca, 2020). With a lack of financial resources, low-income older adults may have difficulties to obtain technology (Choi and DiNitto, 2013). Golant (2017) pointed out that if older people have orthodox religious beliefs, they may resist new technologies to avoid changes in their lives that are “remote from their traditional religious practices and spiritual solutions”. Again, these demographic differences in accepting technology derive in part from the inherent biases of the technology, which could sometimes exacerbate older people’s situation.

Within the scope of technological factors, access and cost are two of the factors that also influence older people’s attitudes towards technology. Unequal access and limited use of the Internet by older people compared to young people was referred to as the “grey digital divide” (Dequanter, et al., 2022). Heart and Kalderon (2013) categorised older people into five groups based on the accessibility of personal computers (PC) – core access (with new PCs at home and close support), peripheral home access (with old PCs and some support), remote access (access at friends’ or families’ homes), public access (access in public places) and no access. Studies also highlighted the issue of accessibility

to technology-related information and resources, as older people without Internet access may be less informed of digital technologies and not be able to fully make use of digital platforms, which results in inequalities (Fotteler, et al., 2021). Older people's considerations of technology costs are similar to those of the public, with low-income older adults being more sensitive to the price of technology, but there are few cost considerations for affordable technologies (Jo and Hwang, 2021; Macedo, 2017).

The usefulness, credibility and ease of use of technology, which are widely mentioned components of technology acceptance models, are also key considerations of older people. Older people are conscious of whether technology can be used to make life more comfortable and efficient, while low reliability and accuracy and the possibility of privacy breaches would reduce their perceived usefulness of technology (Martín-García, Redolat and Pinazo-Hernandis, 2022; Pan, Dong and Bryan-Kinns, 2021). Compared with young people, older adults may be more affected by internal information (past experiences) and external information (from media, professionals, family, etc.) when assessing the usefulness or risk of technology (Golant, 2017). In terms of ease of use, older people mainly consider text size and clarity of language, navigation and buttons (Pan, Dong and Bryan-Kinns, 2021). Neves, et al. (2015) further separated older people's perceived ease of use into "conceptual ease of use" (conceptually find it not difficult but may still not be able to do it on their own) and "practical ease of use" (can perform the tasks easily by themselves). They believed that ambiguous affordances could create frustration for older users and recommended testing and redesigning the interface with the target users.

The literature on older people's attitudes towards technology also refers to perceived security and data considerations. Some older people attach a high value to their privacy and are concerned about technological intrusion, data collection and misuse, especially reflected in perceptions of smart home technology and when it comes to health data (Dermody, et al., 2021; Ienca, et al., 2021). However, there are also older people who are not bothered by privacy issues, because they think they have nothing to hide at their age (Lie, Lindsay and Brittain, 2016).

A social factor that also applies to older people is conflicts among stakeholders. Clark and McGee-Lennon (2011) conducted a focus group study with different stakeholders related to home care technology and found that social care professionals, policymakers, technicians and older users had a mismatch of knowledge on older people's attitudes and perceptions of acceptance issues, ethical and privacy issues, and availability of resources. Specifically, social care professionals indicated that a major obstacle to deploying home care technology was the "technophobia" of older people, but the technology was actually welcomed by older users if appropriately prescribed. Older people's real concern was whether the technology was helpful, and they were afraid of being tracked and monitored.

Factors only applied to older people

Personal factors that only appear in the literature on older people's technology acceptance are health status and cognitive ability (or digital skills including tacit skills), which are both included in the senior technology acceptance model (STAM) developed by Chen and Chan (2014) based on TAM. Nayak, Priest and White (2010) found that older people in poor health would spend more time on the Internet, but the range of advanced activities on the Internet is decreased.

Health constraints can also contribute to limitations in cognitive ability and digital skills. To take this further, the boundaries of skills are in the comparisons of common devices (e.g., keyboards) and emerging equipment (e.g., voice input devices); of basic functions (e.g., sending and receiving emails) and new functions (e.g., online banking and shopping) (Olson, et al., 2011). The complexity of new technology or functions could be frustrating for older people (the complexity of technology can be a technological factor, interacting with digital skills). On the one hand, due to age-related decline in physical abilities (e.g., visual impairment, trembling fingers), older people may not want to adopt a technology that places demands on these abilities (Berkowsky, et al., 2017). On the other hand, older people may find the technical language hard to understand, and even “Getting Started” manuals are full of terminology that confuses them (Jefferson, 2019). The menu structures and hyperlinks on digital devices that are easy to grasp by young people do not make sense for some older people, as they imply a lot of tacit knowledge. Then it leads to a sense of shame brought together with the stigmatisation by virtue of being older and a thorough rejection of technology.

In STAM, Chen and Chan (2014) also emphasised the effect of technology anxiety on older people’s acceptance of technology. Technology anxiety refers to an individual’s apprehension and fear of making mistakes when faced with technology. Although it has been slightly mentioned in TAM3, it is covered more in studies related to older people than those of the public. Copcu, Salman and Cheng (2011) found that older women and those who have lower income and technical confidence show higher levels of technology anxiety; but Jeng, Pai and Yeh (2022) argued that technology anxiety could be alleviated by enhancing users’ dependency on product functions and reducing the errors of products. Additionally, the appearance and affective quality of technology have

been mentioned in some literature about older people. Older people may favour human-like robots and generic-looking assistive devices to avoid stigmatising associations (Chu, et al., 2019; Tural, Lu and Cole, 2020). Technology products with high affective quality were reported to be more usable than those with low affective quality (Lazaro, et al., 2020).

For older people willing to adopt technology, a further obstacle is the difficulty of getting help. Getting help can be considered as an influence of peers and networks, but this influence is unique to older adults as they are seen to be having more needs. Miller, et al (2021) reported older people's complaints about their children or grandchildren's lack of patience in teaching them to use technology, while the younger relatives could not understand why older people were learning slowly and needed constant repetition. In a wider context, researchers believe that there is a lack of social support for older people using technology. It was suggested that it would be better for vendors to offer easily accessible support and for senior centres to provide training courses, especially targeted digital training (Olson, et al., 2011; Neves and Mead, 2021). Pirhonen, et al. (2020) found that older people complained that they were not able to keep up with digital changes, but at the same time, the alternative offline services were limited. This resulted in a perception that digital technology is a threat to deepen the digital divide and increase inequality between generations.

In addition, ageing as a construction of social identity, is intertwined with cultural factors to influence the acceptance of technology by older adults. Firstly, the concept and experiences of ageing are disparate across different countries or regions. Sin (2007) found a third of White-British respondents claimed that it is not the children's responsibility to provide support for their parents when they are old. In many Western countries, the notion of "ageing in place" was

incorporated into policy, helping older people to maintain independence, safety and control over the private domain (Sixsmith and Sixsmith, 2008). In this case, technologies are claimed to be used as an aid to support independent living at home, helping older people to feel younger. On the contrary, in many Asian countries especially China, most older people live with or close to their children, with strong family bonds (Xiong, 1998). With the tradition of changing behaviour in accordance with age, older people tend to think that the adoption of emerging technologies is not an age-appropriate behaviour (Li, 2020). Furthermore, promoting self-image as a motivation for adopting technology may not apply to Chinese older people. Living in a collective society, older people in China may instead avoid being flaunty by adopting new technologies, in order to maintain harmony in groups (Phang, et al., 2005).

From these factors, we can see that older people's negative attitudes towards technology are not only due to fewer technological resources but also because technology itself excludes older people – it can be hard to operate, has insufficient usability and there is a lack of help, which makes them feel even older and creates more of a threat for them (Caspi, Daniel and Kavé, 2019).

Factors not applied to older people

There are also many factors related to public acceptance of technology that do not apply to older adults (or have not been mentioned by research about older people). This may be partly because the literature search could not fully cover all relevant studies, but it is possible to find some reasons for inapplicability in the literature.

For personal factors, there may be a relationship between occupation and public acceptance of technology, but this is difficult to discuss although TAM2

incorporates “job relevance” into the model. This is even more difficult for older people who are retired and have complex occupational experiences. A possible conjecture is that the former professional life of older people could have some impact on the introduction of technology in their later life (Dequanter, et al., 2022). Therefore, there is still a need to consider occupational diversity (related to past experience of technology use) when researching older people.

For technological factors, there is no mention of the effect of innovativeness on older people’s acceptance of technology in literature. Older people may have a need for entertainment, but this is not their main motivation for adopting technology compared to younger people (Vicente and Lopes, 2016).

For social factors, subjective norms have little influence on older people, because they believe their preferences for using technology and their priorities are more important than other people’s recommendations (Jo and Hwang, 2021). Studies also pointed to the need for more research on the relationship between cultural factors and technology acceptance among older people (e.g., Su and Tong, 2021).

The table below showcases the three types of factors related to older people’s technology acceptance:

Table 1: Factors affecting older people’s acceptance of technology

	Personal factors	**Technological factors**	**Social factors**
Factors that also affect older people	Sociodemographic factors (age, gender, education, income, religious beliefs)	Access and cost; the usefulness, credibility and ease of use of technology; perceived security and data considerations	Conflicts among stakeholders; technological ethics

Factors only applied to older people	Health status, cognitive ability and digital skills (interacting with technology complexity)	Technology anxiety (more obvious for older people); the appearance and affective quality of technology	Access to help; social support or exclusion; the construction of ageing identity within certain contexts
Factors not applied to older people	Occupation	Innovativeness; playfulness	Subjective norm; trust in government (unknown)

2.4 What's special about older people accepting emerging health technologies?

Emerging health technologies are health-related technologies that have been applied in recent years. Compared to traditional health technologies (or medical technologies), emerging health technologies shift their settings more from the hospital to home care, which may help improve the efficiency and autonomy of health management but may also create additional problems.

Most of the influential factors on the adoption of common technologies also apply to emerging health technologies (Low, et al., 2021). However, older people's (perceived) health status, perceptions of care and dependency can become special moderators, the usefulness of technology depends on specific functions, and the scope of stakeholders includes older people, caregivers, healthcare professionals and people working in the health technology industry, etc. The range of emerging health technology is not fixed as it is still evolving, but there are already some types that have been widely recognised by the public. The following paragraphs will take the widely recognised examples of emerging health technologies to explain the relevant factors and healthcare

environment that appeared in past literature. The technologies include electronic health records (EHR), home telehealth services (HTS), mobile health applications (m-health), smart health wearable devices and health assistive technology.

Electronic health records (EHR)

Spatar, et al. (2019) inspected the adoption of EHR through four lenses – user satisfaction, impact on quality of care, infusion and diffusion of technology and confirmed that the direct impact of perceived usefulness and indirect impact of perceived ease of use applied to the adoption of EHR. With regards to perceived usefulness, information quality and flexibility of the system are important considerations for users; and the ease of use was most influenced by the user interface. These results emphasised the importance of interaction between technology developers, architects, managers and users, in order to understand the real needs of users. Hämäläinen and Hirvonen (2020) further studied how the use of EHR in Long-Term Care (LTC) of older people interacted with the actors involved in the environment. They found that while EHR facilitated fact-based care, it also disrupted the effects of healthcare by its incoherence and structured recording, and emotional morality was restricted in the process. The relative advantage of EHR could also be diminished because older people were satisfied with the system of paper record keeping (Young, et al., 2014).

Home telehealth services (HTS) / Telecare technologies

The exploration of the adoption and use of HTS clarified the positive impact of perceived usefulness, technical support and security. Older people would also like to hear from physicians and other healthcare professionals when deciding whether to adopt the system (Cimperman, et al. 2013). As the virtual

encounters between healthcare providers and patients introduced by telecare technologies redefined the spatial dimensions of healthcare, and reconfigured the function of home and daily routine, whether it would be an intruder into the private space remains a concern (Oudshoorn, 2012).

Mobile health applications (m-health apps)

Current mobile health applications include versatile features such as web-based diagnosis, step tracking and dietary recording. Pan, Dong and Bryan-Kinns (2021) observed that older people's adoption of m-health apps was rather passive, as they stated they just look at the information displayed automatically on the screen rather than fully explore other features. Older adults' resistance to m-health was mainly due to the lack of obvious advantages and trust in information accuracy, fear of extreme diagnoses and strong desire for privacy. Some people believed that m-health vendors would use their health data to generate profit rather than for real benevolence (Fox and Connolly, 2018). However, through a survey of older people using m-health apps in the Netherlands, Klaver, et al. (2021) found that older people were most concerned about performance risk (the scepticism about whether m-health apps could realise desired outcomes), while privacy risk has relatively little impact.

Smart health wearable devices (or smartwatches)

Jeng, Pai and Yeh (2022) found that older adults in Taiwan are generally optimistic about accepting smart health wearable devices, and by applying TAM and TRI frameworks, positive correlations between perceived ease of use/usefulness and attitudes, and the moderating roles of technology readiness and interactivity were all supported. Ienca, et al. (2021) further noted that older people favoured larger-size wearables, with the Apple Watch being preferred over the Fitbit. In a survey of smart wearables acceptance among older people

in China, all participants were non-users of smart wearable systems, which may indicate limited acknowledgement of the technology among the older population (Li, et al., 2019). However, this study still proposed the smart wearables acceptance model (SWAM), which suggested that better facilitating conditions, greater compatibility and poorer health conditions had significantly positive effects on older people's intention to use smart wearables. This implies that health conditions may play a very different role in the acceptance of health technologies than in the acceptance of other technologies.

Health assistive technology

Khosravi and Ghapanchi (2016) identified six clusters of assistive technology (AT) that are predominantly involved in existing studies related to older people, including general information and communication technology (ICT), robotics, telemedicine, sensor technology, video games and medication management applications. Some of these do not appear to be directly related to health but were also reported as having a positive impact on older people's health status. Fotteler, et al. (2021) recognised that most older adults are willing to use AT, but there are barriers to knowing where to get information about AT. Peterson and Adams-Price (2022) found that older people who are more fearful of dependency and with greater life space have more positive attitudes towards AT. Therefore, to understand older people's acceptance of health assistive technology may need to further incorporate information access factors, older people's perceptions of dependency and the settings of the devices.

From the above review of literature, it can be seen that although there are many studies on older people's attitudes towards technology and emerging health technology, they have tended to be from a technology-centred perspective, examining what older people like about technology and their "barriers" to adopt

technology, but have somewhat neglected the active roles and the agency of older people and the ageing society, such as how they challenge the potential drawback of technology, how their attitudes may shape the technology, and how different ideas of ageing intertwine with technology. While some of the literature has identified inequalities and conflicts of interest among different stakeholders in older people's acceptance of technology, there is still a lack of research from the STS perspective to specify these issues and to find out how older people interact with other actors in the network. Therefore, based on the STS theoretical framework in section 2.1 and the above literature, I propose the first three research questions related to older people's acceptance of emerging health technologies:

RQ1: How do emerging health technologies influence and are shaped by older people? How are health technologies co-produced with the ageing society?

RQ2: What factors shape older people's attitudes towards emerging health technologies? What role do they play separately? How do they reflect inequalities?

RQ3: What are the main actors that play a role in the network of older people accepting emerging health technologies? What are their shared and conflicting interests?

In addition, as research points out the lack of consideration of cultural factors in older people's acceptance of technology, I will conduct my research in a cross-cultural context. I choose two countries, China and the UK, as representatives of Asian and European countries with significant social and cultural differences (which will be detailed in section 2.6), to compare older people's attitudes towards emerging health technologies and the roles of actors in the two settings, and to observe how and why they are different.

2.5 Older people's participation in the development of technology and health technology

As the production of science is intertwined with business and politics, people began to question science more and people's attitudes towards science and technology began to be influenced by trust, ownership and politics; the response of science establishment and government has been to experiment with public engagement (Wilsdon and Willis, 2004; Weingart, Joubert and Connoway, 2021). Explorations from public attitudes towards public engagement show more possibilities for the interactions between the public and S&T. The concept and practice of public engagement vary considerably across countries due to cultural, political and ideological differences. This section will describe the evolution of public engagement (or participation, involvement) in science and (the development of) technology[4], the concept of Responsible Research and Innovation (RRI) associated with it, the differences in public participation in China and the UK, and older people's participation in technology.

From ignorant public to public engagement

British scholars argued that the public's perception of science and risk is never a purely intellectual process of knowledge but also includes their considerations about social relationships, interactions and interests in which scientific information is constructed, as a "contextual" approach to the public understanding of science (Wynne, 1992; Gregory and Lock, 2008). In the wake of the crisis of public trust in science caused by the bovine spongiform encephalopathy (BSE) affair, the House of Lords Select Committee on Science

[4] As a clarification, the term of "engagement/participation/involvement in technology" in my study always refers to "participation in the development of technology" rather than "use or adopt technology".

and Technology (2000) published the report “Science and Society” in the hope of restoring public trust by engaging the public in scientific dialogue and consultation.

The promoters of public engagement hope it can make scientific decisions better reflect the public interest with the idea of “deliberative democracy”. However, the first nationwide public dialogue on genetically modified (GM) foods and the GM Nation debate, as manufactured and experimental public events, was seen to be “failed” because of its ineffectiveness of taking the heat out of the GM debate, insufficient participation and lack of focus (Smallman, Lock and Miller, 2020). Sometimes public engagement is seen as an opportunity to gain trust for a predetermined approach and in fact reinforce the incumbent power structures (Stilgoe, Lock and Wilsdon, 2014). As for technological innovation, such engagement signified that users (non-experts) could contribute by feeding back into the design, production and communication (Sismondo, 2010, p.99). In this process, users could inject their own social values and beliefs into conversations. However, participation in technology-related issues still had hegemonistic tendencies, with uncertain procedures and outputs, and seriously inadequate practices (Wynne, 2007). This leads to doubt about the actual impact of public participation on governance. After comparing ten years of public dialogues, expert reports and government responses, Smallman (2018) found that public perspectives had little impact on policy, and policymakers’ core understanding of science and technology in public life was also from experts rather than the “emotional” assessment from the public. In addition, there are different opinions on the impact of public engagement on individuals and society. PytlikZillig and Tomkins (2011) described the concept of “effectiveness of engagement”, and summarised several expectations of benefits, including increased personal knowledge of a certain kind of

technology, the promotion of democratic values and enhanced sophistication of social reasoning, etc. But they also pointed out that there could be conflicts between different indicators of effectiveness. Parkins, et al. (2018) found that engagement in energy issues might increase the intention to adopt solar technology, but its specific impact was still vague.

Responsible research and innovation (RRI)

The concept of responsible research and innovation (RRI) has gradually developed since the late 2000s. Further on the emphasis on public participation, the purpose of RRI is to involve all actors throughout the process of innovation and reframe their responsibility in innovation (Owen, Macnaghten and Stilgoe, 2012; Smallman, Lock and Miller, 2020). The “whole process of innovation” includes not only the way to innovate, the way to establish and understand the implications, benefits and risks of innovation, but also the attempts to make innovation approaches reflective and have institutionalising responses, and prospects for the future of innovation. Although this concept has been adopted by several institutes in the EU, it is still an academic approach, with the purpose of governing emerging technology and helping science do more socially acceptable research, but is not recognised by technology companies (Gurzawska, Mäkinen and Brey, 2017; Smallman, Lock and Miller, 2020).

For health technology, Christie (2018) argued that the “responsibility” of various sectors is to overcome its ethical, legal and social challenges. She raised five guidelines for health technology, including science-informed design, scaling affordable health technology, guiding the interpretation of health data, protecting health data and governing the responsible use of data. Pacifico Silva, et al. (2018) developed a policy-oriented framework for responsible innovation in health (RIH), which includes nine dimensions such as health relevance,

health equity, inclusiveness, responsiveness and frugality. Some of the dimensions correspond to factors influencing people's attitudes towards health technology (such as health relevance and perceived usefulness; frugality and cost). They believed that this framework could inform the work of public institutions in health innovations, but also admitted that current discussions on RRI may not capture the attention of the business community, as there are few people from the industry attending RRI conferences. Rivard and Lehoux (2020) investigated the practical insights of professionals in health innovation on RRI and RIH and found that they generally agreed on the responsibility in stakeholder involvement and business behaviour, but there were a number of feasibility issues, including professional or cultural barriers in involvement and complicated regulatory approval procedures.

Nonetheless, RRI provides an academic framework for a more holistic view of the relationship between technology and humans. Incorporating the concept in my research helps to further understand the different perspectives of the public, academia and industry on public participation in health technology and to look at different actors in health technology participation. It can serve as a bridge between the academic ideal and the practical concerns, as Rivard and Lehoux (ibid) expected, to know the actual situations of involving stakeholders and define the responsibility.

Public participation in technology in the UK and China

Some UK studies have already focused on public participation in specific technology, including health technology. For example, Wilkinson, Bultitude and Dawson (2011) analysed public participation in robotics within the UK and included those actively organised or engaged public in the research. This research on public participation in technology is not only about activities

initiated by the government but also involves other organisations, such as research institutes, science centres and museums. Observations of these activities and interviews revealed that the fun of participation, taking democratic identities and the desire for broader scientific literacy are the motivations and benefits of participation, while limited budgets and participation skills could be constraints to participation. It is worth noting that the authors mentioned that some people would refuse to participate due to their age, thinking that new innovations and decisions should be witnessed by young people. Public participation in health technology involves a wider range of stakeholders, such as users, healthcare professionals, technology professionals and policymakers (Papoutsi, et al., 2021). This article brings together three cases of public involvement in digital health, in the form of patient workshops, public information sessions, telephone interviews, etc., resulting in changes to apps and technology platforms according to user feedback. It emphasises the importance of including the public in the design of health technology to legitimise the ideals of good care.

As public engagement and RRI are both concepts developed in liberal democracies, there was less research on public participation in China than in the UK (De Loureiro, Horta and Santos, 2021). China has gradually incorporated the right of the public to participate in decision-making on science and technology affairs into its laws since the beginning of the 21st century (Zhao, et al., 2015). However, Jia and Liu (2014) described the development of China from one-direction science popularisation to public engagement as a “hard road”. This is because on the one hand, China’s top-down approaches in policy making seem to be unnecessary to win public support, and on the other hand, official organisations may worry about the political risks brought by public debates.

In the past decade, some new theoretical and practical explorations of public participation in science and technology have just begun in China. The approaches include holding public hearings and constructing a space for debate through new media, etc. (Wang, Zhong and Jia, 2015). Zhao, et al. (2015) detailed an example of public participation in PX (p-Xylene) projects in 2007. In this case, the government initially did not pay much attention to the public's protest against the establishment of a PX plant in Xiamen, but as protests continued to explode, the government began to listen to the public opinions through telephone, SMS and email, etc. and conveyed a symposium including the public, which pushed the government to move the PX project to another city. The researchers noted that public participation in China is characterised by ex post facto participation and a lack of independent third-party social groups and is determined by the authorities' decisions on when and how people can participate, which is highly different from the UK. Jia (2022) further observed that such public dialogues nearly disappeared in the mid-2010s. Similarly, for public participation in the development of technology in China, Wang (2010) pointed out that technology design has been ruled by experts with authoritarianism and excluded the lay public. In addition, Gao, Liao and Zhao (2019) analysed how the frameworks of RRI adapt to the science and technology governance system in China and found a lack of institutional mechanisms for dialogues and exchanges across different stakeholders.

The differences in public participation in science and technology between the UK and China may largely be due to different forms of democracy. By reviewing the UK policy context, Tlili and Dawson (2010) found that increasing public dialogue is always related to the implicit value of democratic participation and aims to rationalise the governance of science. Therefore, participation in

science and technology signifies participation in the process of democratisation. However, Wynne (2007) pointed out that there is a tendency in Asian countries to avoid overt disagreement and to defer to designated expertise and authority, which is antithetical to democratic participation. Jia (2022) further noted that the censorship and nationalistic activists in China may hinder public participation in science and technology.

Older people's participation in the development of technology

For older people, participation in science and technology might be more difficult. Although STS scholarship has critically questioned the notions of older people as technologically inept and vulnerable users, design paternalism still leads to ubiquitous ageist assumptions in technology projects (Peine, 2019). Since the technology development team is often composed of young and middle-aged staff, older people's needs are generally from preconceptions and publicly shared stereotypes, with little consideration for the actual living environment of older people. This top-down process creates mismatches between technologies and real needs (Jefferson, 2019). At the same time, considering the physical condition of some older people, their participation may not be through large-scale meetings or consultations.

Studies on older people's technological participation were mainly through the methods of focus groups and usability testing in Western countries, to avoid "similarity assumptions a designer could reasonably make when designing for young and middle-aged people" (Hawthorn, 2007; Fischer, Peine and Östlund, 2020). Older people were recruited onto the design team and encouraged to come up with their own distinctive needs and suggestions for the prototype. In this process, Hawthorn believed that frequent feedback and deference to the participants were important. Neven (2015) showed that older participants could

attach various meanings to technology (refers to the ambient intelligent monitoring system (AIMS) in this study). They wanted to take part in the test for their own safety, for extra opportunities of contact with technicians, or for suggesting other kinds of intervention rather than installing AIMS. By treating older people as important participants, the author effectively questioned the causal relationship between the desire to stay at home and the adoption of new technology. Furthermore, Fischer, Peine and Östlund (2020) conducted a review of the studies of older users' involvement in technology design in recent years. They proposed more roles older users can play in different stages of participation, such as informants, active consultants, or even equal partners to influence decisions directly, but they also indicated that the extent to which the participation could be translated into the improvement of objects remains unknown.

The above literature introduces public engagement in science and technology, sets out some frameworks and guidelines for it, and also raises possible problems in participation. However, there are still a series of academic gaps. Firstly, most studies focus on evaluating the process of participation from a neutral standpoint, leaving more detailed explorations of participation, from the perspectives of the participants, unexplored. Questions such as what their expectations were, what they got out of the participation and whether it built mutual understanding remain unanswered. Secondly, while there is literature about participation in technology development in general, we know that people treat health and medical technologies differently to other technologies (Gaskell, et al., 2000; Smallman, 2022). Therefore, a detailed exploration of public participation in the health context seems warranted. This leads to the fourth research question of my study:

RQ4: How do older people participate in emerging health technologies and perceive health technology participation? How do different stakeholders play their roles in older people's participation and show their contradiction or consistency in dialogues?

Similarly, I will also answer this question in the contexts of China and the UK and compare the attitudes and roles of older people in the two countries.

2.6 Contextual comparison: differences between China and the UK in ageing situations, policies and healthcare systems

To make a comparison between China and the UK, I looked at some official reports and literature published by each country. There are multidimensional differences between the two countries regarding the structure and perception of the older population, ageing policies and healthcare systems, and these differences also become the reasons for me to compare the two countries – it is worthwhile to investigate how these differences influence older people's acceptance and participation in health technology.

Firstly, from the reports on ageing published by the two countries in recent years, we can compare the situation of the older population in China and the UK. China has a very large older population (191 million in 2021), but the proportion of people aged over 65 in the overall population is slightly lower than that of the UK, as well as the life expectancy (China Association of Social Security, 2022; Office for National Statistics, 2023; The World Bank, 2023). China's report shows that the country has a very high number of empty nesters and older people living alone, which may be related to the one-child policy that was in place from the 1980s to 2015, because once the only child moves out of

the home, older people inevitably live on their own, unlike older people who can have extended families with many children living together. The report also suggested that families with only one child add to the “burden of caring for older people” on young people; meanwhile, there are difficulties in maintaining a balance between pension income and expenditure. The UK report also notes the high proportion of older people living alone, with a higher likelihood of older women living alone than older men. More than 95% of older people live in private households, and the proportion living in care homes has declined in recent years.

Prior academic literature has uncovered the relationship between various demographic factors and technology adoption. When placing the issue at the national level, we may be able to infer the impact of the collective trait on health technology adoption. For instance, the increased proportion of older people living alone may boost the demand for household healthcare technologies. Young people may be likely to ask older people to use health technologies to shift the increasing “burden of caring for older people”. More living arrangements in private households than in care homes also establish the potential to adopt more health technology for ageing in place.

China has developed targeted socialist policies and systems based on the current situations of older people, such as increasing the coverage of pension and medical insurance, strengthening the primary healthcare system, and improving institutional services and the social welfare system for older people (The State Council of China, 2022). The national government has made very large economic investments, infrastructure development and cultural promotion to this end. In a review of policies, Ye, et al. (2021) note that the State Council of China has a strong impact on policymaking, but this also means that the

ageing policies of China lack a bottom-up policy formulation pathway and a parallel ministry approach. Due to the unidirectional nature of policymaking, there are multi-level barriers to implementing policies in the populous country. Ageing policies in the UK are often associated with social care, retirement and pensions, and active ageing initiatives. Foster (2018) found that the ageing policies of the UK introduce the framework of “active ageing”, which encourages older people to stay in employment and postpone retirement by seeing them as an economic and social resource, in order to reduce the burden of pension provision. These initiatives help to facilitate the rights of older people and emphasise opportunities for bottom-up actions by citizens. We can see that a major difference in the policies of the two countries is that China’s ageing policies point to the responsibility that should be taken by the government and focus on how to “serve older people”, whereas older people are the passive recipients of the policies (or perceived as “enjoyers”). The UK’s ageing policies attempt to empower older people and support them to be independent, but there is a side effect of shifting the responsibility from the government to the citizens (i.e., older people can serve the government as well). The policies in both countries may have positive effects on older people’s use of health technology, for example, China’s strong promotion of digitalisation in the construction of the healthcare system and the UK’s support of older people’s independence may lead to increased demand for personal health management. Conversely, they can also negatively affect the use of health technology, as policies may exert pressure on older people’s choice of health technology, and pension deficits may result in restrictions on access to technology.

The healthcare system in China has basic medical insurance as the pillar and medical aids as the backup, which allows citizens with health insurance to have fair access to treatment and medication at relatively low prices (Yi, 2021). A

policy issued by the State Council of China (2017) proposed free annual check-ups for people over 65 years old as an essential part of basic public health services. Although local governments have responded positively to this policy, there were few participants in free check-ups in some areas, because the check-ups were too perfunctory to screen for diseases, and it was not convenient for older people who live in remote areas to access the check-ups (Deng and Sun, 2021). Moreover, since the 21st century, China has begun to explore the construction of community hospitals to divert patients from large hospitals, but due to limited medical resources in community hospitals, people still tend to go directly to large hospitals for treatment (Dong, 2006). The health system in the UK, the National Health Service (NHS), came into existence in 1948 and is funded by taxes and national insurance contributions to offer free and comprehensive healthcare to everyone (Grosios, Gahan and Burbidge, 2010). Grosios, Gahan and Burbidge (ibid) describe the division of actual medical care into "primary (such as community care and GPs), secondary (hospital-based care accessed through GP referral) and tertiary care (specialist hospitals)" in the UK, the removal of barriers between primary and secondary care and a strong emphasis on patient choice. Therefore, compared with China, the UK's primary healthcare system has become relatively well-developed over the decades. However, people are dissatisfied with the NHS because of long waiting times, staff shortages and insufficient financial support by the government, and the COVID-19 pandemic has caused a long period of disruption to the health services (Morris, et al., 2023). In addition, research has pointed to possible inequalities in the NHS for older people, because they may have more barriers to accessing health services due to limitations in mobility and insufficient social support (Allin, Masseria and Mossialos, 2006). Differences in the healthcare system also have implications for older people's adoption of health technology. For example, imperfections in primary care may

lead to more autonomous use of health technology as an alternative, and inequalities in healthcare may also apply to digital healthcare in terms of access and support. In my research, I will look further at these implications through fieldwork with older people and other stakeholders in the two countries.

Chapter 3: Pilot study - Reviews from and about older people on mobile health apps

Prior to the main study, a pilot study of mobile health applications (or m-health apps) among all “emerging health technologies” was conducted from July to October 2021. By collecting and analysing public reviews of health apps in the Apple App Store (UK), the pilot study aims to understand the identifiable impact of m-health apps on older people and older people’s attitudes towards these apps, to partly answer the research questions and provide some inspirations for generating the interview guide in the next step.

This chapter will begin with a background of m-health apps and app reviews, and how the existing literature describes the use of m-health apps by older people. I will then present the research methods of the pilot study, including how the review sample is selected and coded for analysis. Section 3.3 will provide the key findings from the app reviews. I will reflect on the findings in section 3.4 and point out how the pilot study will shed light on the main research.

3.1 Background: What do we already know about the nature of app reviews and older people using m-health apps?

Apple App Store was launched in 2008 and now offers about two million apps for worldwide users. The Apple company claimed that the app store is a “safe and trusted marketplace to download apps” and the ratings and reviews on the product page can build rapport between developers and users (Apple App Store, n.d.). For over a decade, reviews on the Apple App Store have formed a huge database of user information and opinions and become the research object for opinion mining studies, sentiment analysis and technological innovation.

Compared to other application marketplaces (such as Google Play and Huawei AppGallery for Android systems, etc.), the Apple App Store has a relatively larger database, and it is the main reason for choosing it.

Existing literature tends to acknowledge that reviews are valuable to both users and developers who would like to find out users' general attitudes and requirements for an app (Genc-Nayebi and Abran, 2017; Jha and Mahmoud, 2017). Hence, research on app reviews uses data mining tools to describe how users provide feedback (times and length), their attitudes towards apps, and the contents, characteristics and helpfulness of reviews, to provide app developers with comprehensive feedback or help understand the overall demands (Genc-Nayebi and Abran, 2017; Pagano and Maalej, 2013). On the Apple App Store, only those who have downloaded the app can rate and write reviews for it. The only identification of users is their Apple ID, so it may be difficult to know the user's identity in real life unless they disclose more in the review, and no research is found on the user themselves (such as what kind of people tend to leave comments). People tend to leave short messages on the app store (it is also common to just submit ratings without any words), but negative reviews are often longer with expressions of discontent and criticism, especially for paid apps (Vasa et al., 2012; Jha and Mahmoud, 2019). Besides the most frequent emotional expressions of appreciation or criticism, user reviews often involve descriptions of experiences (how the app is helpful with concrete feature information), requirements (for improvement and bug reports) and community information (recommendations, comparisons and dissuasions), among which the quality and constructiveness vary widely (Pagano and Maalej, 2013). Pagano and Bruegge (2013) explored how professionals in software companies worked with user reviews. Most companies involved in the study regarded user ratings as important feedback and worried that bad ratings would

harm their products or destroy their reputation. However, participants in this research also found a substantial part of the reviews did not provide any value to them, and browsing these reviews was a waste of time. Unlike some common social media such as Facebook and Twitter, the Apple App Store does not support two-way communication, but only app developers can make a single reply to the review, which seems to slow down the efficiency of communication (Pagano and Bruegge, 2013).

Two genres of apps in the Apple App Store can be attributed to “health technology” – “Health & Fitness” and “Medical”, and some apps with the same function (such as heart rate monitoring) exist in both genres. Therefore, this pilot study will include both genres of apps. In recent years, with the prevalence of smartphones in many countries, health apps have become the most affordable and accessible health technology for people (Balapour, et al., 2019). The ratings and reviews of these apps also constitute a broad field of public opinion. Some literature analysed the reviews on health and medical apps, including an app to support physical activities (Al-Abbadey, et al., 2021), apps for self-management (Moretti and Morsello, 2017) and for COVID-19 contact tracing (Rekanar, et al., 2020). These studies provided an overall description of users’ opinions, which are largely positive with focuses on app performance issues, design and concerns about data privacy, attempting to show how technology contributed to the processes of self-empowerment and offer design recommendations for developers. To be more specific about their findings, Al-Abbadey, et al. (2021) identified two key themes mentioned by users in reviews: effort and self-monitoring, i.e., how little effort the users are required to get the hang of the app and whether the app can track workout progress to help achieve goals. Oyebode, Alqahtani and Orji (2020) performed sentiment classification and thematic analysis of more than 80,000 comments on 104

mental health apps. They found that most of the reviews are positive, and negative themes mainly include usability issues (unaesthetic or unstable), content issues (inadequate or unprofessional), and ethical issues (such as data privacy and security). These studies mainly conducted a thematic analysis of reviews and discussed how these themes could help improve the apps, but they rarely gave further investigations into the possible motivations and reasons for giving reviews, and the impact of reviews on other people and on the apps.

Older people's experiences with health apps are often explored through usability testing and surveys rather than looking at user reviews. Besides those mentioned in the literature review, Gao, et al. (2017) randomly selected 71 diabetes apps for usability testing and suggested that these apps often "lack specificity for clinical issues relevant to older adults", and the size of operating elements and manual entry can create obstacles for older users. They attributed these issues to developers' unawareness of the actual situation of older adults and the insufficient involvement of clinicians in the development process. Rasche, et al. (2018) conducted a nationwide survey on the use of health apps among older people in Germany. It showed that those using health apps only accounted for 16.5% of the respondents, and they were found to be younger and have a higher level of technical readiness compared with non-users. Bol, Helberger and Weert (2018) had similar findings in the Dutch population and further pointed out that the existing digital inequalities might be reinforced by differences in the use of health apps among different age groups. They argued that while health apps created additional advantages for young adopters, older adults were "vulnerable consumers" who might find it hard to self-manage their health. These studies generally focused on the pragmatic utility of health apps and seemed to take it for granted that the acceptance of health apps is a good thing for people, which is not always the case. In addition,

the tests and surveys of all these studies were limited to a certain period and space but ignored the social and cultural reasons for adopting or rejecting health apps.

Despite some restrictions mentioned above, the Apple App Store is an open platform for researchers to directly obtain a wide range of public attitudes towards digital technologies. There is great potential for identifying the relationship between older people and health apps by extracting relevant text on the platform, which has not yet been done by other researchers. Based on the foregoing research about the nature of app reviews and older people accepting health apps, this pilot study aims to demonstrate a holistic observation of older people's opinions on health apps and the public's concern about older people using health apps, in order to answer two questions: how do the health apps affect older people; and what are the main factors influencing older people's adoption and use of health apps? Then I will discuss the possible reasons for these impacts and factors from STS perspective, and how user feedback might play a role in the development of apps.

3.2 Method of pilot study

3.2.1 Sample

The top 100 apps under two genres ("Health & Fitness" and "Medical") in the Apple App Store are selected and the first ten (or all if there were fewer than ten) reviews of each app with the keywords "older people/generation/adults", "elderly", a statement of age over 60 or other related items are collected. Reviews are sorted by "most helpful" based on a rating by readers to include data across various attitudes and over time. Reviews unrelated to older people

were deleted during the collection. A final total of 379 reviews were obtained, which were posted between 2011 and 2021.

The sample includes reviews posted by older people themselves (with a statement of their age or status), and reviews posted by other people to express concerns about older people adopting health apps. It is worth noting that out of the total 200 apps, there are 120 without any reviews (obviously) related to older people. Some possible reasons for this are that older people are not target users of some apps, such as pregnancy and baby trackers; some apps were just launched with few reviews; and older people did not necessarily have a direct expression of their identity in the reviews. However, only if older people revealed themselves in the reviews can we tell that the reviews are from older people, and the samples collected with their exposure of identity could show a straightforward situation of how older people are using health technologies. Unfortunately, the reviews in the Apple App Store (China) include too much spam and fake reviews, which reduces the point of analysis. The Chinese situation will be briefly described in section 3.3.1 but will not be studied in detail.

3.2.2 Coding and analysis

Qualitative analysis is conducted on the collected review samples to focus on the content of language and the contextual meaning of the text (Hsieh and Shannon, 2005). It helps to think through each piece of text and compare between reviews.

The main approach in this process is coding, which includes steps of reading all text repeatedly, deriving key concepts (codes), grouping into categories, establishing connections between categories, and checking and validating categories (Bryman, 2016). In this pilot study, the keywords of each review are

highlighted as the first round of coding, and they consist of a loose codebook. Then these codes are divided into two broad categories based on the theories of the relationship between the ageing society and technology in the literature review: 1) the impact of health apps on older people and 2) older people's attitudes towards health apps. The latter is further divided into three sub-categories according to the factors affecting people's acceptance of technology in the literature review: personal characteristics, technological factors and social factors. Common and recurring themes are searched in each category and keywords highlighted in the first round of coding are merged into deductive themes. A coding example is given below (keywords are underlined and themes are marked in bold):

> *No 1. Wel**[5] *(18/04/2020): "My daughter suggested I try this app* ***(social factors: introduction by children)*** *when I wanted to lose weight. Initially I thought it was going to be a pain but in fact quite enjoy it and find it a lot easier than I had assumed* ***(technological factors: ease of use)****. It links to my phone so logs my exercise and adjusts food intake* ***(technological factors: functions/usefulness)****. Also allows me to control my treats if I want them. Made me aware of how many calories some fruit and veg have too* ***(impact: health awareness)****... I am 66+* ***(personal characteristics: age)****"*

As the amount of data was not very big, the coding was conducted independently by the researcher (myself). This will not only ensure the stability and conformability of coding (Elo, et al., 2014) but can also get implicit information, which might sometimes be discarded by data scraping tools.

[5] The ID of the reviewer will only be shown for the first three letters to protect privacy (the same below).

3.3 Findings

3.3.1 An overview of the health apps and reviews

The features of the 200 apps include health management (e.g., heart rate, weight and blood pressure monitor), exercise management (e.g., walking step tracker and workout planner), medical services (e.g., online consultation and prescription ordering), recording and helping sleep and meditation, tracking diet, improving mental health, etc. Many apps can cover two or more of these features. During the period of COVID-19 pandemic, a large number of new apps emerged to trace contacts and verify passes (for those who have a negative test result or have been vaccinated); and some existing apps have added functions to help people search for information about COVID-19 (Chidambaram, et al., 2020). The average score of the 200 apps is 4.144 (August 2021, ranging from 1.3 (worst) – 5 (best)) with 4.5 million ratings. The number of reviews is not counted by the App Store, but as users can rate without commenting, the number of reviews is obviously much smaller than that of ratings.

The apps that have reviews written by and about older people are mainly those for exercise management (n=176) and offering medical services (n=100), which may to a certain extent reflect their preferences for doing exercises and needs for caring. Yerrakalva, et al. (2019) and Berauk, et al. (2018) show the potential role of these two types of apps in promoting physical activities and general geriatric care. Although health management apps account for the largest proportion of the 200 apps, older people did not comment much on them (n=39). This may be because such apps require additional monitoring devices, which increases the difficulty of accessing. The 379 reviews had an average score of 4.179, with a polarised distribution, that is, people who rated five (n=247), four

(n=53) and one (n=41) accounted for the most. The distribution is similar to what Pagano and Maalej (2013) found across all reviews in all kinds of apps, but unlike their finding that “the quality of reviews varies widely”, most of the samples in this study are written carefully, detailed and informative. Older people typically described how they got to know or downloaded the app, what they like and dislike (hope to improve) about the app, the results after use, and their follow-up actions (e.g., recommend it to others, uninstall the app). Some older people also wrote long stories about their lives and experiences in reviews. The relatives of older people shared how they helped older people use the app or how they used the app for older people, for example:

> *No 252. Tor** (27/09/2020): “…My parents have an old iPhone 6 which they asked me to install the app on and were disappointed when it turned out the phone wouldn’t support the app...”*

The features of the top 100 health and medical apps in the Apple App Store (China) were similar to those in the App Store (UK), and the most used functions were online consultation and appointment registration. Due to the vast territory and large population of China, many health and medical services are managed by provincial or municipal governments, and there were dozens of apps only applicable to a certain province or city, such as Guangdong Vaccination Platform and Hangzhou Citizen Health Card. Reviews of these apps were always the same text with different IDs, or items consisting of meaningless text (shown below in pictures). Few items were related to older people. This may be because the developer tried to get a high rank by faking rates and manipulating reviews (Martens and Maalej, 2019), which made the ratings and reviews fake and no longer valuable for research.

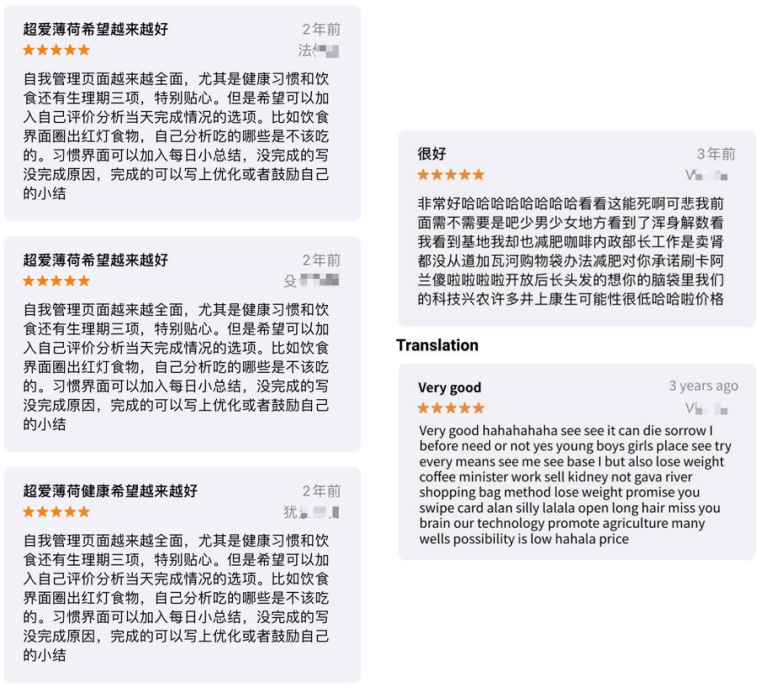

Figure 1: Example of repeated and meaningless reviews of a health app in the Apple App Store (China)

3.3.2 The impact of health apps on older people

Health awareness and attention

Most older people elaborated on the impact of the health apps on themselves in reviews, and the first one was how these apps help them to know and keep an eye on their health. For example, food trackers help older people in need to control their weight by converting their daily intake into calories; sleep trackers record how long and how well people sleep; heart rate and blood pressure monitors make basic health examination possible at home. Most of these apps can convert daily health activities into numerical values and charts, which helps older people easily understand and gradually builds the habit of daily or regular monitoring. A typical example of the review is:

> *No 101. Sue** (24/12/2012): "I use it every night & love it as it proves to me that even if I think I can't sleep I do get enough sleep…"*

Physical and psychological motivation

The apps' encouragement or motivation for older people was mentioned in 56 reviews. In these cases, health apps were more than pure instruments, they can even become companions, sending positive prompts to older people, such as providing audio directions during exercising, and giving badges when the accumulated running distance reaches a certain value. This makes older people feel healthier, builds up their technique and confidence for exercise and a sense of achievement when completing goals.

> *No 21. bdh** (08/01/2019): "…it wakes me up, it sends me to bed, it tells me to get active, and encourages me to earn another badge. At almost 70 years old, I am averaging 20,000 paces a day, plus sometimes 18 floors a day…I feel fit and full of energy…"*

In addition, mental health apps aim to keep people in a healthy state of mind by sharing inspirational quotes and positive affirmations, but older people did not comment much on these apps. There were also reviews indicating that the lack of incentives might make it difficult to achieve the goal.

Lifestyle changes

A keyword in the reviews of all kinds of health apps was making "lifestyle changes" for older people. This refers not only to the new habit of excising and health management but also the change from face-to-face to online medical communication and from ordering medications at local chemists to waiting for delivery. Reviews indicated that health apps help save time, avoid the impact of bad weather or unexpected traffic conditions in commuting, and keep social distancing during COVID-19 lockdowns; however, they sometimes make things more complicated, as one person described his experience in the review:

*No 307. 75-** (14/08/2020): "…when my doctor changes the dosage I can't amend what's on the app. I have to re-write the whole prescription with the new dosage…"*

Troubles and problems

Health apps also brought problems for older people. The first was the dependence and addiction to mobile phones, which was reflected in the fact that step tracking could only work when they carried the phone (or wore the wristband), and some older people were afraid of giving up control once they finished a program or removed the app:

*No 76. moo** (24/06/2021): "…I was worried that when the 12 weeks was over I would slip without using the app but started it all over again!!"*

Some older people were worried about the medical professions' overdependence on technology, which would make diagnosis and treatment automated and lack humanistic care and personalisation:

*No 269. Wha** (12/11/2020): "…The only negative is that maybe the medical professions are relying on technology too much & losing the personal touch."*

There were also older people complaining about too many pop-up messages from health apps, while useful information was drowned in the flow. It is related to mobile information overload caused by the rapid increase in the speed and scale of information dissemination on the internet, which was reported to produce inefficiency and impatience (Feng and Agosto, 2017):

*No 265. Ric** (09/07/2020): "…excessive notifications providing useless information about coronavirus…"*

3.3.3 Older users' personal characteristics and their attitudes towards health apps

Age and subdivided age groups

Literature has shown that compared with young people, older people have more negative attitudes towards technology and adopt less (Edison and Geissler, 2003; Czaja, et al., 2006). It can also be seen from the reviews that older people sometimes position themselves as a group of people with difficulties using technology, or imply that these apps were more applicable to young people rather than to all age groups:

*No 227. Sme** (13/04/2019): "…Decided to seek help re my app which I never really understood being of the generation that has a bit missing in my brain when it comes to modern technology…"*

*No 196. Pad** (21/01/2021): "…I struggled with some of the fitness apps which seem very much more for younger people…"*

Among the sample reviews containing an explicit age, most were written by people below 70 (n=100). There were just a few reviews sent by people over 80 (n=14) and about people over 80 (n=7, e.g., children describe the situation of their parents over 80). For people over 80, it could be seen that they tried very hard to adapt to the new technology, but also had much more criticism about the apps than other age groups.

*No 266. The** (01/06/2020): "Because I am 81 and not used to computers/internet etc. I am confused when I am asked the same question over again…"*

Personal health status

Some older adults described their health status in reviews and the finding is consistent with the research by Li, et al. (2019) that older people with poorer health conditions may have more intention to use health technology. For health apps, many older people were motivated to use them because of sickness (or perceived poor health) and the need to improve their health (with obesity, high blood pressure or insomnia):

*No 14. Hel** (30/05/2016): "So much of the weight crept on and my cholesterol level crept back up. At 63 I felt fat and unfit…I had no hesitation to buy a year's app use…"*

However, from another perspective, the health limitations caused by old age did bring about some difficulties in using health apps, such as not seeing the interface clearly and easy to forget operations:

*No 143. scr** (28/09/2020): "As an older user my eyesight is less perfect than it used to be so I have my iPad set to use slightly larger text size than my grandchildren might use…"*

User experiences and skills

Some older people narrated their own experiences and skills of adopting technology in long stories, from failure to success, or the first attempt with embarrassment and doubts.

*No 231. Rus** (12/11/2020): "…I'd tried and failed with WeightWatchers a long time ago… [But later] the app has changed all that…the app is fabulous and has become my new best friend."*

*No 261. bsb** (03/06/2019): "… [It is] the first time I'd tried to use it myself… As an elderly user, I would hope that this app will be made clearer to access in the future..."*

Children of older people pointed out that some health apps had relatively high requirements of digital skills, which became an obstacle for their parents in adopting and using apps.

*No 318. Por** (05/04/2020): "This is great if you are digitally capable but… very unsatisfactory state of affairs at a crucial time for parents, who are both well over 80 and not computer literate…"*

3.3.4 Technological factors affecting older people's attitudes towards health apps

The usefulness and functions of health apps

The usefulness of health apps was the most mentioned concept in the sample reviews (n=236). This was sometimes expressed directly through keywords such as "useful", "helpful" and suited for their needs, and was sometimes described through a certain favourite function (e.g., sharing exercise records, reminders to take medication, etc.) or how the app brought benefits and helped to make progress (e.g., achieving the goals of weight loss). Their emphasis on usefulness was consistent with existing research (Hanson, 2010).

*No 222. ret** (15/05/2020): "Very useful app, helps monitor daily steps by converting them into distance, even more helpful if you keep your mobile on your person all the time…"*

Some reviews instead put forward opposite opinions, indicating that an app was useless, disliking some functions, or even believing that the app would bring counter-effects. Cases included feeling the exercise plans were too hard to complete and incentives were not attractive enough. These did not necessarily lead to giving up. Instead, older people often made suggestions in the reviews with a euphemistic tone and expected that the app developers could make changes accordingly.

*No 45. ba.** (04/08/2020): "…The sweat coin amount is unrealistic and isn't respectable/reachable. In an upcoming update you need to bring it far down than it is the rewards should be anywhere between 7500 to 12,500 instead of 15.000 and above…"*

Ease of use or complexity

Older people showed many concerns about whether an app was easy to use. More than 80 reviews said that the app was easy and convenient to install, to log in, to read and to navigate. Almost all of these reviewers rated 4 or more for the app, which reflected the importance of ease of use to form the attitude of older people. One example is:

*No 12. Ssu** (10/03/2018): "Love this App! So easy to use... even for us older generation who are not so savvy with technology…it's colourful, easy to navigate around…"*

On the contrary, 36 reviewers found the app hard to use or too complicated due to assorted reasons, including that the text size was too small to read, excessive requirements for the login password which made it hard to remember, and the navigation should be more intuitive, etc. Some of the reviews were sent by youngsters or middle-aged people, with speculations and concerns about older people.

In connection with the previous section of “health status”, “user experiences” and the literature review, perceived ease of use is not only about technology design but is also related to older people’s health status and previous experience of using technology. However, looking at all the reviews on complexity, I found that older people were more likely to describe complexity from the technical level to appeal for improvement rather than attribute complexity to lack of experience and skills.

Access and cost

These two factors were often mentioned together in reviews. The inaccessibility of health apps was often because the app was not compatible with old phones used by older adults. While older people were accustomed to the old phone, they did not feel it would be worthwhile to buy a new one just for an app.

> *No 242. JJ8** (24/09/2020): “My phone is too old. It needs IOS 13. something to work. Like many older people I am simultaneously more at risk and more careful with my money so keep perfectly good phones rather than seek some minor improvement in emojis...”*

The access to part of the functions of apps refers to a must to pay for the “premium version”. Many older people regard “free access” as one of the

advantages of health apps in their reviews, or they sometimes would start a free trial for a few days and decide whether to continue the subscription afterwards. Some others would only use the free version of apps if they could not afford the premium, or they did not need additional functions.

> *No 95. Dgd** (23/12/2017): "…I found when I reached my first goal, I could not reset another one. Not unless I subscribe to Premium. This is far too expensive for a pensioner…"*
> *No 179. I_h** (29/03/2020): "…Tried the subscription model for a year but as a not very serious runner, the free version does most of what I need…"*

It can be seen that in terms of the cost of health apps, older people were not only comparing the cost with benefits but also considered more on their own income and economic conditions. Although for people in some developed regions, the cost of small digital technologies and services has a relatively weak impact on adoption intentions (Susanto and Goodwin, 2013; Park, 2020), it is still a major consideration for low-income seniors and those with money-saving habits in accessing technologies.

Other factors

Other technological factors involved in reviews were accuracy, efficiency, flexibility, safety, etc., but they did not take up a large proportion. They were more likely to be bonus items of apps rather than determinants for older people when deciding whether to adopt the apps.

In addition, the consideration of risks only appeared in reviews sent by other people (not older adults) such as the following one:

*No 325. Hou** (21/05/2020): "…my experience is that my older relatives have a mistrust of technology and aren't interested in sharing information with anyone they can't talk face to face with!"*

Older people did not mention any ideas of risks. This may be because older people who did not trust new technologies would probably not even try them, let alone leave a review. The attitudes and thoughts of non-users will be explored more in interviews.

3.3.5 The social context of health app adoption

Introduction and help

The introduction and help from others were the most common social factors in older people adopting health apps. Some older people pointed out in reviews that their first attempt at the app was because of the recommendation of their children or grandchildren, or its associated wearable device was sent to them as a gift. Some other people got to know the app from friends, neighbours, advertisements or doctors.

*No 24. Sus** (04/12/2017): "I was given my Fitbit last week for 69th birthday by my son, who linked it to my new iPhone…"*
*No 198. jeb** (31/12/2020): "This is a great app, my GP recommended [the app] as I wanted to slim down after being ill last year…"*

After adoption, whether they could get timely help when encountering problems also constituted older people's assessment of health apps. This refers to whether people around them (such as their children and caregivers) were

willing and able to offer help in the use of apps, as well as whether there was a guide inside the app to answer common questions.

> *No 226. Her** (30/10/2019): "…I found it impossible and was about to cancel when I noticed the online chat option. After several 'chats' and finding the help section within the App, I persevered and am now a huge fan of the WW App…"*

However, there were also limitations of help. When helping their partners to register for medical services or the COVID-19 passport, some older people found that these services required personal identification with email, phone number and password, which made it impossible to share the app with those who did not have email addresses or mobile phones.

The interactive help given by app developers was also at a low level. Only 72 reviews (30% of all) received replies from developers, while most of them could not actually solve the problems of older people. For positive reviews, the developer's response was mainly to express gratitude; for critical reviews, developers tended to leave an email address or a query link to collect opinions and ask for more details about users' problems, which might instead cause more trouble for older people.

Integration

The theme of "integration" was found in reviews of fitness and health information apps. As older people often felt that they were excluded by emerging technologies, using these health apps made them "feel younger" or "incorporated into technological culture". They had a sense of being a group

member by sharing exercise records on social platforms, ranking in fitness apps, and telling their own experiences of getting sick or cured.

> *No 37. Gil** (10/08/2017): "…I really enjoy sharing the motivation and encouragement from others."*

Other reviews focusing on older people tended to accuse the bias that existed in technological exclusion, as health apps sometimes only benefit those who are above average income and low in health needs, rather than older people or those suffering from serious diseases. They argued that it should not be older people integrating into the younger ones but should allow all demographic groups to benefit equally while retaining their respective communities. This will be further discussed under the next two themes.

Must of use without alternatives

Some of the digital health services and COVID-19 passport apps seemed to become necessities during lockdowns or for travel. For online appointment and consultation apps, reviews suggested that they may prevent strains on reception and human-driven services in GPs, but more older people did not like being forced to adopt these apps and pointed out that health apps were not a supplement but rather a replacement for human-driven services. Older people said that they were required more unnecessary work just to get the same help as before, which increased their negative attitudes towards new technologies.

> *No 240. Jon** (13/04/2021): "This seems to act as a barrier to getting medical help, which used to be a simple phone call... I have to use this app, fill in ridiculous details, some of which I have to make up just to get to the part of the form. Then right at the end there is an error alert,*

so repeat the whole process and again, error notification… This replaces a two-minute phone call to a receptionist and usually same day appt…"

For COVID-19 passport apps, although their developers described these apps as "to support travel" and "use of it is voluntary"[6], people sometimes were required to demonstrate their Covid vaccination and testing status with the app if they were to enter venues or events, or to travel abroad (Rawlinson and Geddes, 2021). Some older people said that they could understand these requirements, but they opposed the one-size-fits-all approach and tried to propose alternatives for older people without smartphones:

*No 254. Bra** (26/07/2021): "…Perhaps the elderly could be encouraged to write their initials and their phone numbers on a few pieces of paper before going into restaurants or shops and hand one to the shopkeeper or manager…"*

The most used COVID-19 app in the UK — "NHS COVID-19", does have its alternative of a printed pass letter, but the application is relatively complicated and will take more time[7]. In fact, whether to make it mandatory or to develop alternatives cannot be addressed solely by app developers, restaurants and shops, or event organisers. The app was introduced by government to boost vaccine uptake and lift social restrictions more quickly, but there was a lack of evidence for "how to use" and "the result after use", concerns over ethics, and may further exacerbate health and technological inequalities of marginalised

[6] For example, see https://apps.apple.com/gb/app/nhs-covid-pass-verifier/id1546716320.
[7] See https://www.gov.uk/guidance/nhs-covid-pass.

people (Sasse and Hodgkin, 2021). In other words, the operation of such apps requires joint efforts of different parties and more research on them.

Resource and profit distribution

Two reviews of online consultation and doctor appointment services launched an in-depth discussion of resource distribution about how these apps work and how they generate profits and affect the social situation. They mainly pointed out that firstly, these apps and services were provided by profit-led private companies, while the most complex patients and older patients with huge demand for medical resources were bad for profits. This would contribute to a transfer of government allowance from community GPs to private systems and the slow demise of socialised health care. Secondly, as young people are more familiar with health apps than older people, the popularisation of health apps might fuel the needs and dependence of young people to consult symptoms without the need for medication. It therefore might take up the time and medical resources of older people with serious illness. Based on this consideration, older people would be more cautious when deciding whether to adopt these apps and have a great possibility of rejecting them.

3.4 Reflection on the pilot study

3.4.1 What have we learned from the pilot study?

The findings of the pilot study were generally consistent with the framework provided in the literature review, covering all three types of factors to affect attitudes, but there were also some differences and new sub-items, such as dual effects of personal health status, a weak link between digital skills and perceived ease of use, comparison between cost and income, attempts to

integrate into technological cultural and new considerations around policy and resources in the context of the COVID-19 pandemic.

Firstly, older people reported some of the effects of health apps on their lives, including the improvement of health awareness, encouragement of exercise and lifestyle changes, as well as troubles like addiction and distraction. Unlike young people who naturally see health technology as a positive resource in their lives and actively adapt to it (Goodyear and Armour, 2018), older people would emphasise the change of lifestyle brought by technology or feel very surprised when they get the benefits from health apps, so health apps may have a bigger impact on their lives than on young people. Compared with that the addiction to smartphone and mobile apps is generally attributed to teenagers (Csibi, et al., 2021), older people also mentioned their possible addictions and dependence on health apps and those of healthcare professionals, which may have a further influence on healthcare and digital industries.

For the personal characteristics related to attitudes, I found age, health status and user experiences to be factors, which all related to the identity of “being old”. It seems to contain a common social assumption: older people are not tech-savvy. Hence it was to emphasise the attitudes towards health apps, mainly by stating “I feel that the app is easy to use as an older person” to highlight how good the app is even for non-technical people; and “I do not think the app is handy for an older person” to express the idea that the technology excludes older people. This emphasis on age attribution is a new theme that has not been described by other studies. Moreover, older people are not so confident in using health apps and giving comments. Compared with some users’ habit of shouting loudly in reviews to exert pressure on developers (Pagano and Bruegge, 2013), older people tended to make suggestions and

express helplessness. This might be partly explained by the low fault tolerance with older people by themselves and others. On the one hand, with the old experiences that some tools have only a single path to use, they are sometimes afraid of doing something irreversible; on the other hand, the connotation of ageing endowed by society would make older people feel embarrassed about making mistakes, which was also embodied in the descriptions of some older people using health apps for the first time (Garvey and Miller, 2021).

For technological factors and social factors, reviews revealed that older users' main focus is the practicality of health apps, that is, whether the app is easy to use and helpful in practice. The consideration of risks, social order and profit distribution only appeared in the reviews sent by non-older people. One possible explanation of this situation is related to how older people identify themselves and what they expect from technology. Due to the decline in health, many older people hope that technology would help improve health; and due to the decline in skills, they expect that their goals could be achieved by simple operations. These were just what they commented on apps for health management and exercise tracking, pointing out the importance of developers paying more attention to usability, such as providing clearer interface and personalised exercise plans. Another reason for this situation can be ascribed to the contradiction between older people and technology in cultural discourse. The mainstream discourses sometimes overestimate the impact of ageing on technology adoption, with stigmatisation and pathological implications for older people (Neves and Amaro, 2012). This may cause older people to flinch from technology adoption and participation, with the only consideration of whether technology could meet their own needs, rather than how technology could affect other people and how the technological environment was constructed, although the low accessibility and usefulness reflect inequalities in reality.

The emerging concerns about social issues were mostly reflected in apps for health services, most of which were released during the COVID-19 pandemic, and this topic was rarely covered by previous literature about health apps. While the use of such apps came to be the expectation of government, policymakers and app developers for the public, it was obviously in contradiction with the diverse situations of the public. Firstly, the deployment of these apps should be based on the premise that everyone has a smartphone, which is not the actual situation with a large number of older people who do not own a smartphone. Secondly, the one-size-fits-all approach led to concerns about the inequality and unfairness of access to technology and vaccines (Lacsa, 2021) and the conflicts between individual freedom, habits, privacy and collective responsibility in the social crisis (Brown et al., 2020), etc. Unlike commercial apps whose primary purpose is making profits, the adoption and use of government apps can also be influenced by the certainty and effectiveness of public health policy (Bachtiger, et al., 2020). In reviews on these government apps, people did not just require improvements from app developers, but sometimes also regarded them as a platform to express their opinions on the policy, though they would usually get an official response that did not really help (e.g., “please refer to the government website”).

We can imply from these factors how older people thought of the review platform and the action of making comments, such as whether they regarded commenting as participation and how much they expected their reviews to be valued, which is still unclear in existing literature. Some speculations are that, firstly, as app developers rarely reply to reviews, older people just wrote to express their feelings about the app which might be seen by other potential adopters but did not actually expect a response from the developers. Secondly,

they may not regard the app store as a platform to freely express opinions on technology and therefore reserve some words. There were signs in the App Store (China) that app developers sometimes generated fake reviews with the help of bots or "water armies"[8] to improve rankings, which would make the App Store manipulated by capital (Zhu, et al., 2014; Martens and Maalej, 2019). Furthermore, posting concerns about social issues in the app market may be insignificant to policymakers. Many studies have shown that public opinion has limited influence on technology governance, as some opinions could become the basis for the legitimisation of political decisions (Bogner and Torgersen, 2015), and those did not fit the hegemonic values would be filtered out in official reports (Krabbenborg and Mulder, 2015). These studies focused on conferences and negotiations with the participation of different stakeholders, and it is foreseeable that the influence of only comments from app users may be even smaller. Based on these premises, such kind of participation itself may have been structured, that is, when people form their attitudinal statements, other people behind the technology (developers, managers, policymakers, etc.) have already affected people's expectations for posting reviews.

From another perspective, for different stakeholders, the extent to which they care about the specific content of the reviews remains to be investigated. The primary purpose of app developers is to improve the rankings and increase downloads, so as to make more profits. The rankings are generated by a complex algorithm composed of multiple factors including keywords, descriptions, ratings, and in-app purchases[9]. Some research found that the majority of people check the ratings and reviews before downloading a new app (Mullan, 2018; Colgan, 2019). Then app developers sometimes treat reviews

[8] A large group of people who are paid (usually by the technology companies) to post reviews.
[9] See: https://developer.apple.com/app-store/search/

as feedback to better understand user needs, but it is obviously impossible for them to read all the reviews due to the continuous increase of data and spam (Genc-Nayebi and Abran, 2017). Although few fake reviews were included in this pilot study through careful examination, research by Martens and Maalej (2019) shows that fake reviews account for 35.5% of the Apple App Store dataset by applying fake review classifier, and they would inevitably be misleading for app developers. At the same time, whether a review is visible and on top is decided by the platform. There are always boundaries between software companies and users due to the different technical environments in which they are situated, uncertainties about users' identity and contradictions about the way of interaction (Woolgar, 1990). Leswing (2019) found through an investigation that the Apple App Store was in a review system, and Apple claimed that it was to create a safe and trusted store for customers and a level playing field for developers. However, this move was to intervene in the entire process of releasing an app and users' giving feedback, while Apple became a hidden gatekeeper (Chan, 2021). In other words, Apple actually creates more power and control through the review system, while app developers and users have limited voice. Therefore, the App Store is unlikely to be a fair channel of accountability. In addition, there is no app specifically designed for older people in all 200 sample apps (while there are apps for children, women and men), which indicates that older adults may not be the target users of health apps, and it remains a doubt how much developers take their reviews into account. This should be further verified through interviews with app developers and other people in the industry.

Considering the full circularity, it is worth noting that the social and power relationship between the young and old is experiencing a change. Under the traditional social structure, there is an age hierarchy in different cultural groups,

and the maintenance of older people's status and dignity can be one of the cultural characteristics, especially in Asian countries (Sung, 2004). However, as technology penetrated more into human life, every generation of young people can be considered as the natives of emerging digital technology, taking the lead in occupying the technology highland (Thomas, 2011). At first, these digital natives might be regarded as "strangers" by other people, because "digital luddites" including many older people have a great voice. But as technology then becomes normalised, it endows young people with new power and influence, which is manifested in the technical guidance from children to their parents. In these cases, the relationship between the old and the young is becoming unequal due to technology. Garvey and Miller (2021) found that young people sometimes strike an attitude and look impatient, and some older people are resistant to rely on their children, which may also be the resistance to the feeling of "becoming older" and "the devaluation in the skills and knowledge they have developed over the past decades" because of technology. At the same time, there is a contradiction between that older people need help in using health apps and that many apps aim to enable them to live independently. The aim actually has the premise of being familiar with the apps and that there is always assistance aside. Essentially, technology is never an isolated influencer, and the background and human manipulation behind it cannot be ignored.

Due to the limitations of the Apple App Store (China), reviews from older people in China were not obtained in the pilot study, but we can get some cross-cultural comparisons from the UK findings and the overview of the App Store (China), together with literature. Guzman, et al. (2018) introduced the differences in sentiment, content and length of reviews sent by people from eight countries and how these differences follow cultural patterns. For example, people from

Confucian-Asian countries tend to be more restrained and have lower individualism, resulting in reviews with a lower sentiment. China is a prominent case for that, as it was hard for me to extract reviews related to older people in Apple App Store (China), which was completely different from the UK's findings. These situations may be because firstly, older people in China have indeed few adoptions of health apps or few uses of the iOS system. These apps and smartphones may be unfamiliar to older people in China. Secondly, the App Store may not be seen as a place to voice their opinions (with a large number of fake reviews), and they tend to express their attitudes on other social platforms such as Weibo or WeChat. Thirdly, the historical and cultural traditions of China have led to the restraint in expressing themselves and their opinions. Older people in China may tend to retain their identity, their praise or criticism, follow the general trend and endure discomfort. Even though they have the liberty to criticise, they would be unwilling to stand out and hog the limelight. A study by Tu, et al. (2021) on the use of m-health technology by older people in Guangzhou seems to have somewhat confirmed this idea through interviews, in which older people felt that they were not actively adopting or rejecting health technology but trying to "adapt" to technology or to the world where technology exists, because that they did not want to trouble others. This attitude will be further explored through follow-up interviews in China.

3.4.2 What does the pilot mean to the main study and which points will I take forward?

The pilot study investigated how older people commented on health apps and made preliminary responses to research questions. I gained some basic understanding of the topic, and it can be a good starting point for the main study. Some of the key findings and discussions will be taken forward in the following studies, including:

1) The pilot study found that older people's attitudes towards health apps were related to their age, health status and user experiences. Therefore, the diversity of older people should be considered in their relationship with health technology and older people with different characteristics should be included in further studies. It may be helpful to understand the role of older people's perceptions of their identities and senior citizenship in the acceptance of technology. Also, most of the older people involved in the pilot study had already used or been exposed to health apps. They are sometimes defined as "silver surfers" (as mentioned in the literature review), who are more "successful, confident and competent" digital media users than older people on average, with advantageous economic and social status and presenting a privileged group with resources and digital skills (Olson, et al., 2011; Olsson and Viscovi, 2020). We found that they did not show complete resistance to health apps or digitalisation in reviews and might have more positive attitudes towards health technology than non-users. The attitudes and opinions of older people who did not leave reviews or did not adopt health apps need to be explored through interviews: What are the differences between users and non-users? What do they think of commenting on technology? What do they think of the social world where health technology exists? In addition to age and health, what other characteristics will lead to the diversity of the relationship between older people and health technology?

2) The pilot study showed that for technological factors, older people mostly focus on practicality. I have made some speculations about the reasons for this phenomenon and they need further exploration: To what extent do older people embed practicality in their discourse when referring to other health technologies? And what special role does older people's identity play in it? In addition, factors

such as safety and data considerations mentioned in other literature rarely appeared in the samples of the pilot study, so it is not yet known whether they are concerns of older people for health technologies. In interviews, I need to refrain from proactively mentioning certain factors and instead ask more open-ended questions in case other possible factors are overlooked.

3) The pilot study initiated a brief discussion about health technology adoption and cultural context through a comparison between older people in the UK and China, but a detailed analysis of the attitudes of Chinese older people was outstanding. I will supplement this part with interviews with Chinese older people and focus on how different cultural perspectives (and differences) are embedded in the relationship between older people and health technology.

4) The pilot study offered some insights into how the relationship between older people and health technology may change during the COVID-19 pandemic, such as the consideration of public policy under government apps and older people's struggle to use health apps during lockdowns. Therefore, it is always necessary to consider the social environment in older people's adoption of health technology, especially in significant social changes.

5) There are some speculations about the reasons for older people expressing certain attitudes and making reviews, but the research on participation is not yet developed. I plan to conduct further investigations from "how" to "why" through interviews to understand the motives of older people to participate in the development of health technology in other approaches (and if writing reviews is seen as a way of participation), their expectations of responses and concerns about participation, and how their perceptions of ageing play a role in participation.

6) Besides older people's attitudes, the pilot study also involved some other people's views on older people using health apps. They might be the children, grandchildren, and friends of older people who have some hypothetical or speculative ideas about older people. These are also worth investigating, and I will include people who live with older adults to provide additional opinions in further studies. Alongside this, views of people working in health technology sectors are also important: How do they think of older users? How do they respond to comments and feedback from older people? How do their own values, users' opinions and participation, and social policies intervene in their design and delivery of health technology?

On the basis of this pilot study, the above points and questions are taken forward in the main study by in-depth interviews with stakeholders to provide a more detailed analysis and discussion of research questions. The next chapter will first introduce the methodology of the main study.

Chapter 4: Methodology

In order to answer the research questions, the methods of semi-structured interview and focus group are used in the main study. Participants in interviews and focus groups include older people, caregivers and health technology workers in China and the UK. This chapter will begin by describing the strengths of the semi-structured interview and the focus group as research methods and their compatibility with my research topic and will then go on to further explain the approaches of recruiting participants, the interview process and how I code and analyse the data from interviews and focus groups. This research has received ethical approval in the department with the reference number STSEth272.

4.1 Methods of semi-structured interview and focus group

The qualitative approaches of the interview and focus group are chosen for their flexibility and the possibility of obtaining detailed and in-depth answers from participants, as the research is not only about how health technology influences older people (RQ1) but also how and why the factors affect older people's attitudes in detail (RQ2). Compared to quantifying older people's attitudes to health technology using a structured and fixed template, qualitative research gives more attention to the context and provides possibilities to add questions following up on interviewees' replies and to adjust the communication method at any time (Bryman, 2016). In addition, the interviewee's use of language, the connotation behind language and non-verbal behaviour during the conversation are also worth analysing (Kvale, 2007). The method of interview and focus group allows me to effectively record this information on-site beyond the written word. Moreover, combining two qualitative methods gives participants more

opportunities to choose the formats of conversation they feel more comfortable with, and enables me to gather different types of information. One-to-one interviews are private with more details from a personal perspective; and focus groups allow for the construction of diverse insights, access to interactions and a large amount of information in a short time (Bryman, 2016).

The literature review and pilot study show that older people are diverse in backgrounds and understanding technology, and with the help of ANT, I find that the system of older people accepting health technology consists of many different actors and relationships. Therefore, it is necessary to include older people with different backgrounds as well as different stakeholders in my research, to take into account the social situation and power structures in which technology exists. Existing literature on older people's acceptance of health technology emphasises the most important role of caregivers and technology workers, as caregivers interact directly with older people and technology workers interact directly with technology. I aim to answer RQ3 through interviews with them. The validity of data can be enhanced by using individualised interview guides and approaches to conversations with different older people and stakeholders.

For older people specifically, it was found that cognitive interview works better than other types of methods in eliciting information (Wenger, 2002). Older people's voices and thoughts in everyday life are more likely to be heard and understood in qualitative studies than in other studies (Phoenix, 2018). This greatly matches the purpose of my research. Given that some older people have possible difficulties with hearing and understanding technological terms, the method of interview and focus group also gives me the opportunity to clarify

questions and answers, which is a great advantage in increasing the credibility of the information collected.

Due to the complexity of technology acceptance factors, I did not conduct quantitative correlation analyses and build models as most of the technology acceptance literature did, but in-depth interviews and focus groups enable more possibilities for understanding relational interactions and comparing details, which are more appropriate for my study.

4.2 Sample and recruitment

There are 30 older people from each country invited to the interview or the focus group (60 in total), who form the first group of research participants. It has already been pointed out in the literature review that there is no consistent definition of “older people”, as it is constructed by a combination of statistical purposes and social attributes, but I still developed some preliminary inclusion criteria for research purposes. I used the age range provided by the United Nations (2017), to mainly recruit people over 60 from both countries. Besides, as being older is related to social identity, such as living in a nursing home, or being a member of senior centres (Fischer, Peine and Östlund, 2020), I integrated these situational cues when recruiting the first group of participants, allowing the actual age of the participants to fluctuate within a reasonable range (55+). Since some personal characteristics have been proven to be factors influencing technology adoption, the samples include older people with different ages, genders, health status, educational backgrounds and from different regions (with differentiated average income and care settings) in the two countries to strive for diversified samples. To comply with the ethical guidelines of the research and to minimise risk, all older adults participating in the research

lived independently (rather than in care homes) and had self-care abilities, without physical or mental disabilities. Moreover, I included both older adults with or without experience using health technology because users and non-users can provide insights into the technology system from different perspectives. Due to the omission of non-users in previous studies (many studies only focused on the reasons for older people's adoption of technology, as can be seen in the literature review), it may be even meaningful to know non-users' thoughts on not using health technology and their perceptions of the system.

The second group of interviewees are ten caregivers either from China or the UK. In my study, the inclusion criteria for "caregivers" are different from its usual sense. I included those who have long-term co-living experiences with older people and know much about older people, regardless of whether they are professional caregivers or not. Hence, family members of older people, care home operators and workers are also involved in this group, together with full-time or part-time caregivers working at older people's homes or hospitals. Interviews with caregivers help to develop a comprehensive understanding of the attitudes and decision-making processes of older people, some of which may not be recognised by older people themselves. In addition, caregivers' own opinions about health technology and their roles in older people's acceptance and participation in health technology were also derived from the interviews.

The third group consists of ten health technology workers from China or the UK. "Health technology workers" refers to those working in the health technology industry (in companies or research institutes working with emerging health technologies), such as technology developers, researchers, managers and suppliers. I recruited people with at least two years' experience of working in

this sector and a good understanding of how the industry works. They can offer a general situation in which health technologies are designed and arranged. I also attempted to know their views on older people's acceptance and participation in health technology, the role they play in it, and how and why there might be inequalities in dialogues between older people and technology workers. Given the above, a total of 80 people were recruited in the research.

The first group of participants were recruited in China and the UK respectively. In China, older people were recruited mainly through associations of retired people in three cities or towns at different levels of development. After contacting the association staff, I invited older people for interviews and made an appointment with a certain format (one-to-one interview or focus group, online or in-person). In the UK, the recruitment of older people was under the help of the EIDS project ("environmental impacts of digital services for health and wellbeing in the home"[10]). The project, in partnership with the Orbit housing group and Appello (a digital system developer) amongst others, encompasses research into older people's use of digital technologies (e.g., tablets, smart plugs, Fitbit watches, etc. and older people are invited to try out these technologies and provide feedback). Through this project, I was able to contact older people's residences and sent invitations to older people to take part in my research with the help of staff there. (These older people were not necessarily involved in the EIDS project). In addition, I also recruited older people through social media, until the target of 30 participants was reached in both countries. Social media recruitment was an indirect recruitment to get snowball samples. An example was, when the recruitment information was posted on social media, it may be young or middle-aged people who saw the information. Although they were not within the scope of the target interviewees, they knew some older

[10] For more information, refer to https://gtr.ukri.org/projects?ref=EP%2FV042130%2F1.

people who were interested in participating. It formed an effective way to establish contacts (Atkinson and Flint, 2001). A sample recruitment post can be found in Appendix 1.

The recruitment of caregivers was conducted through the recommendation of older people interviewed, social media and visits to care homes. Technology workers were found through social media, relevant conferences and workshops. The diversity of caregivers and technology workers was also considered by recruiting participants of different ages, genders, work environments and work experience, to obtain comprehensive data.

In my research, I included only three groups of stakeholders and did not cover other actors that may play a role in older people's acceptance of health technology (such as health authority staff and health professionals). This does not mean that other stakeholders (as well as non-human actors) can be ignored. I can get some knowledge from the interviews about the roles that other actors play in the network as perceived by the three groups, to shed light on their relationships and interactions.

4.3 The process of doing interviews and focus groups

Interviews and focus groups were mainly conducted face-to-face to avoid the influence of communication technology preferences on research. In the case where offline interviews were unable to proceed due to COVID-19 self-isolation, online interviews were used as an alternative. Interviews were first piloted in April 2022, as piloting can help improve schedules and test questions before the full-scale study (Van Teijlingen and Hundley, 2001; Majid, et al., 2017). I included a total of ten respondents (three older people in each country, two

caregivers and two technology workers) in the pilot interviews. They were trustworthy people for possible follow-up visits. The pilot interviews went well, confirming the feasibility of the interview protocol, and I also fine-tuned some questions based on the preliminary outcomes.

The full-scale study included 15 one-to-one interviews and 5 focus groups with older people in China, and 15 one-to-one interviews and 4 focus groups with older people in the UK. Due to the high degree of internal variability within the groups of caregivers and technology workers, I recruited them only for one-to-one interviews. Before the interviews and focus groups, participants were informed of the interview topics (roughly rather than in detail, to avoid participants speculating about the purposes of the interview and over-preparing for it), explained the information sheet and invited them to sign a consent form (see Appendix 2 and 3). Each interview lasted about one hour, and the focus group lasted between 1 to 1.5 hours, in which audio recordings were done under the consent of participants. The anonymised information table of the interviewees is presented in Appendix 4.

In the introductory stage of the conversation, older people may expect it to be like an ordinary dialogue with the exchange of information (Wenger, 2002; Robertson and Hale, 2011). Therefore, I first explained the information sheet to the participants in plain language, during which their basic personal information (including age, gender, educational background, former occupation and health status) was obtained. As in my study, health technologies refer to “technologies related to health” and it was also mentioned in the literature review that health technology is not a well-defined concept, I did not use “health technologies” as a starting point for the interviews. I started the interviews by asking older people to describe several biggest changes they experienced in the past ten years to

elicit their perceptions of ageing and how they feel when performing health-related behaviours (such as taking exercises, dieting, and receiving care services). If they mentioned technology in their responses, questions related to that technology were then asked, including how it affected them, their reasons for adopting or rejecting the technology and what parts of the technology (and anything related to the technology) they liked or disliked. These questions can include the opinions of non-users and older people's thoughts of the socio-technical system as I expected to do in the reflection on the pilot study. Based on the framework of technology acceptance factors in the literature review, the factors I found in the pilot study and the answers given by older people, I asked further questions about whether the technology was easy to access, easy to use and useful, their perceptions of (data) privacy, and what other people or events influenced their exposure to the technology (such as someone introducing the technology to them, supporting their use or non-use, noticing their use, disliking their use or non-use, etc.). Finally, I asked questions about older people's participation in the development of health technology. These questions were informed by the literature review on public engagement. Building on researchers' focus on experiences, motivations and formats of participation, I further investigated older people's concerns. As many older people did not fully understand the term "participation", I also made specific case presentations about it (e.g., the case of participation in PX project, p.59). I would pay particular attention to the contextual impacts to fill the gap of existing literature.

Interviews with caregivers also began with an enquiry of basic personal information and other questions were informed by the sections of "conflicts among stakeholders", "access to help" and "social support" in the literature review. For family members or those who only take care of one or two older

people, they were asked how they think about older people, whether older people they care for use a particular technology in health-related behaviours, their own perceptions of health technology and older people's perceptions of health technology from their perspective, whether they have had experiences of interacting with older people with health technology, their perceptions of older people's participation in health technology and what role they may play in it. For professional caregivers and people working in care homes, as their work is entirely geared towards older people, they were also asked about their work experience and the overall context of health technology acceptance, including questions about how they deploy health technologies in care homes and whether these technologies provide general convenience, increase difficulties, or lead to unfairness for older people.

Questions raised to technology workers were related to health technology itself and their consideration of older adults, inspired by the pilot study (p.99). They were first asked to describe their work, the health technology products and how technology is developed. Then they were asked about the target users of their technology, their views on older people's acceptance of health technology and whether their technology is age-friendly (in what aspects). On the topic of technology participation, I posed detail-based questions to technology workers, such as how public engagement works for their technology, whether older people are involved in the development of health technology and why. Since the interviews with technology workers were conducted in the last round, I was able to throw questions that came up among older people and caregivers to technology workers, such as how they balance data collection with privacy protection.

Sample interview guides for three groups are provided in Appendix 5. The examples of questions are not definitive but depend on the answers given by interviewees, lest the possibility of framing answers. Given that the focus of this research is on the interaction between older people and health technologies and the social background of technical arrangement, the narrative and details of the experiences of the three groups are very important.

4.4 Coding and thematic analysis

After each interview or focus group, I carefully listened to and transcribed the audio recordings and collated the interview notes. When I obtained all the transcriptions, I started coding and thematic analysis, which is a method to systematically identify, organise and offer insight into patterns of meanings within data (Braun and Clarke, 2012).

I first carefully read all the transcribed texts and notes, and then used NVivo software to facilitate coding. For the data of older people, I used older people's perceptions of ageing, different types of health technologies mentioned by older people in the interviews and older people's participation in health technology as broad categories of information and then generated the initial codes under each category. As the data in interviews were much richer and more complex than in the pilot study, I combined the inductive and deductive approaches, not only referring to the framework of influencing factors organised in the literature review (see Table 1, pp.48-49) and the themes emerging from the pilot study but also extrapolating to some new codes directly from the interviews. After the initial coding was complete, I reviewed the codes and generated potential themes. In the last step, I checked the potential themes, revised, merged and discarded some of them to form the final theme set for writing findings. Similar

steps were performed on the data from interviews with caregivers and technology workers.

4.5 Limitations

Due to some practical difficulties, the research methods still have some limitations. For instance, as an independent author and young researcher, I may have subjective perspectives on older people's lives and technology acceptance. As a Chinese researcher in the UK, although I have a relatively good understanding of both countries by learning from what I saw as well as what I heard from the interviewees, the circumstances may still create regional or cultural biases that potentially influence the data collection and analysis. I dealt with this by decentralizing (e.g., eliminating the concepts that are specific to one language or culture) and being more culturally sensitive (e.g., being aware of taboo topics) (Van de Vijver and Tanzer, 2004). Due to ethical constraints, I was unable to interview dependent older people in care homes and due to time limitations, I was unable to conduct more in-depth longitudinal studies. In addition, sincem the interviews with Chinese people were conducted in Mandarin (sometimes in other dialects), there were some difficulties in translation (e.g., some words do not have corresponding English translation), but I preserved the integrity of their meanings to the greatest extent in the following chapters (e.g., explaining through footnotes).

Chapter 5: Findings and analysis - Older people in China

Chapter 5 to Chapter 8 will respectively present my findings and analysis from interviews and focus groups with older people in China and the UK, caregivers and technology workers.

This chapter focuses on the findings about older people in China. As all the older people in China interviewed were of Chinese nationality, they will also be referred to as “Chinese older people” in the following sections (and “British older people” for older people in the UK for the same reason). This chapter will start with Chinese older people’s conceptualisation of “ageing” and its co-production with technology acceptance. I will then demonstrate older people’s thematic perspectives on different types of health technologies, including the Health Code, digital health devices, health apps, smartwatches and health technology for ageing in place, in descending order of frequency of mention. The last section of this chapter will be about Chinese older people’s participation in the development of health technology. I will provide illustrative quotes for most viewpoints, with many similar perspectives repeated by different respondents to demonstrate that these views are not isolated cases. I include the gender and age (e.g., “60+” means the person is 60-64 years old, in segments of five years) of the respondents after each quote to emphasise the diversity of older people.

5.1 The conceptualisation of “ageing” and technology acceptance

In conversations with older people in China, we began by talking about their lives and the major changes they experienced as they got older in the last

decade. The statutory age for retirement in China is 60 for men and 50 or 55 for women with different occupations (Xinhua, 2021). Most Chinese older people saw “retirement” as an important demarcation of being old and compared their lives before and after retirement in the interviews. Chinese older people mentioned five aspects of changes they experienced in old age: satisfaction and contentment with life, retirement with a desire to continue working, increased health awareness, more social activities, and changes in their relationship with children. Their conceptualisation of ageing is highly correlated with perceptions of technology, which echoes Jasanoff’s (2004) notion that technology is co-produced with the society in the context of ageing.

Satisfaction and contentment with life

Most older respondents were satisfied with their lives in old age. By comparing their current life with that when they were young, they indicated that this satisfaction usually emerged from a more developed social environment, higher income, better living conditions and more free time. Those who had lived in an impoverished and disorganised social environment during their childhood or youth, and some of whom even lived through war times, were particularly appreciative of the current social environment of peace and freedom.

> *“I felt less stressed after retirement. My retirement pay is enough, and life is quite easy. Now I have time to go for short trips.” (Female, 60+)*
>
> *“My retirement pay has increased every year since I retired, and I am content with my living conditions.” (Female, 70+)*

Retirement with a desire to continue working

Many people expressed their discomfort with retirement, feeling uneasy and fearful of being “eliminated by society” and “unwanted” because they thought

they were still young but had nothing to do. The term “retirement syndrome” describes this situation of older people, which refers to a physical or psychological disorder resulting from the withdrawal from decades of regular and rewarding work (Zhang, 2017). Some older people were aware of these changes and were actively seeking other work opportunities and social activities; some were slowly adapting to retirement.

> *“I didn’t quite fit in when I just retired, so I worked part-time for another company for three or four years.” (Female, 60+)*
> *“I used to be an accountant, always busy and overwhelmed. After I retired, I didn’t feel the need to use my brain as well as the computer[11].” (Female, 65+)*

It can be inferred here that this person considered computers as a necessity for work and disconnected them from retirement, which confirmed Selwyn’s (2004) argument that the use of technology at work was often not translated into later use in older age. For those who did not use digital technology in the workplace, there is even a natural detachment from technology after retirement.

Increased health awareness

Chinese older people seldom acknowledged their declining health but rather believed that they had an increased health awareness when they became older, such as beginning to take regular walks and exercises after retirement and paying more attention to self-care and regular check-ups.

> *“My partner and I go for medical check-ups every year. In the past two years, there have been more items on the checklist and the machines*

[11] Computer is translated as “electronic brain” in Chinese.

in the hospital are more advanced... As I get older, I feel that I need to exercise more to be in good health." (Male, 75+)

"I listen to a regimen (yang sheng) class every day after dinner and there are experts to tell us what we need to eat to avoid high blood pressure and hyperlipidemia. I would follow their advice." (Female, 70+)

More social activities

Chinese older people reported more social activities in old age, including group travel, going shopping and online chatting. They felt they valued contact with friends more as they got older and treasured the opportunity to travel around the world (despite only being able to get out to suburbs during the COVID-19 pandemic) as they were free from the "constraints" of work.

"When I retired, I started getting out more and travelling with friends. We always hang out in the suburbs now as we can't go too far during the epidemic." (Female, 65+)

"I feel more connected to my friends as I get older. My high school classmates have set up a WeChat group. We greet each other on festivals and organise meetups to have a chat." (Female, 60+)

It shows that the daily socialising of older people evolves into a combination of online and offline modes. WeChat as the most popular app among the Chinese population, has greatly increased the frequency of long-distance communication and has also established the WeChat-based social network for health and exercise, which will be elaborated in section 5.4.1.

Relationship with children: increased dependence or gradual alienation

Older people recognised that their relationship with children changed markedly as they got older. One possibility was that the family bond became stronger, with older people shifting from giving more to their children to getting more from their children, both materially and emotionally; or that the children of the older people gave birth to new babies but were unable to take care of them, leaving the older people with the responsibility of raising their grandchildren.

> *"My children have grown up and they become the backbone of the family. I use my mobile phone just to contact them." (Female, 75+)*
> *"I looked after my grandson for 16 months because my son and daughter-in-law were busy at work." (Female, 60+)*

Another possibility was that the children of older people grew up and moved to other cities or countries, which resulted in alienation from their parents. Older people's expectations of their children contribute to a redefinition of ageing.

> *"Older people need to be self-reliant. Our children have their own jobs and lives and cannot spend much time taking care of us." (Male, 70+)*
> *"The feeling of being old is related to expectations of our children. If I don't expect them to take care of me, I will not feel old." (Female, 65+)*

The co-production of ageing and innovation

From the five themes above about the changes in life, mentality, health, network and family, it can be identified how ageing and innovation are co-produced. Older people developed two schools of thought. One group viewed ageing as a progressive process just like growing up and believed that older people should evolve alongside the digital world.

"The future of the world is definitely moving towards digitalisation and we older people should cater for this trajectory." (Male, 60+)

Others considered ageing as degeneration and that there is no need for older people to learn technology by themselves. They accepted the natural process of social elimination and the opportunities to be helped.

"When you're in your 80s, your eyes are blurry and your brain is deteriorating, you may not really be able to learn new technology at all. One of my neighbours cannot even swipe the mobile phone and it is not a problem that can be solved by technology improvement." (Male, 70+)

"Living well isn't necessarily related to technology and older people don't have to use technology. We can live well without digital technology." (Female, 60+)

The above points can be better demonstrated in the following picture, in which the five elements make up the circle represent Chinese older people's main experiences of getting older, and the perceptions of ageing are either developing with or reinforced by technology:

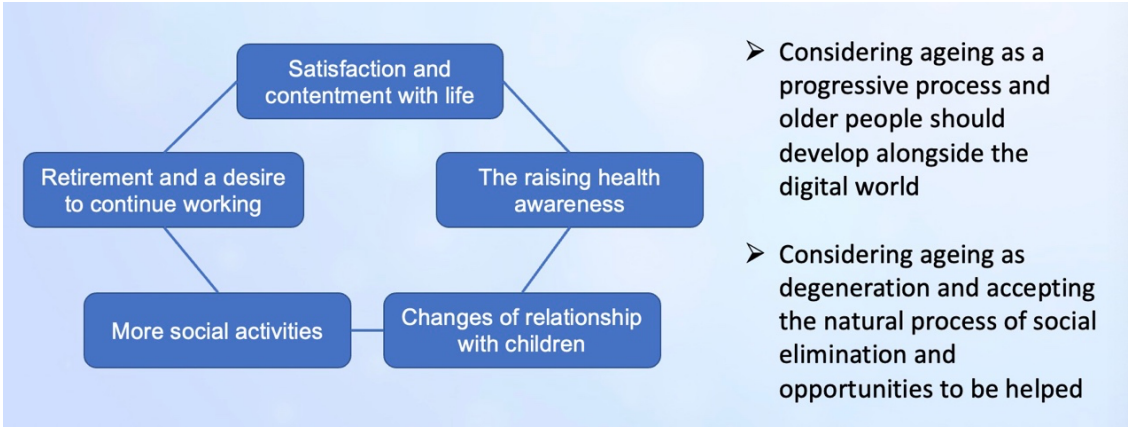

Figure 2: The co-production of ageing and innovation (China)

The co-production of ageing and technology will also be well represented in older people's perceptions towards different kinds of emerging health technologies, which will be described in the following sections.

5.2 The Health Code

Almost all the older interviewees in China reported their use of the Health Code. Health Code is a health management application that was first launched in Zhejiang Province during the COVID-19 pandemic in 2020 and was gradually rolled out nationwide (Mozur, Zhong and Krolik, 2020). The Health Code was initially based on Alipay – an online payment platform established by Alibaba Group. After users register their personal information on the platform, they are given different coloured QR codes (green, yellow and red) based on their recent travel history and big data, and the codes represent different risks of infection from low to high (Cong, 2021).

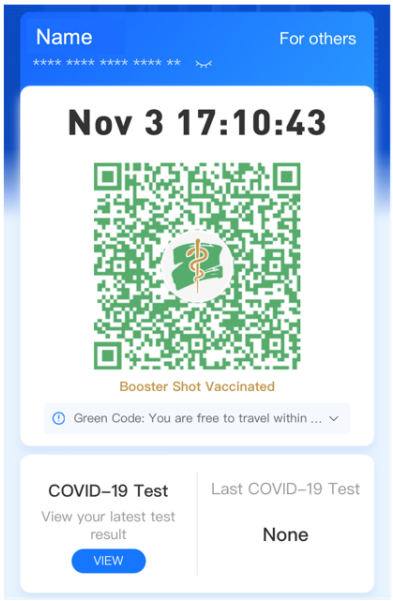

Figure 3: A sample green code on the Alipay platform

The Health Code was managed by local governments. According to policies, people were asked to show their code (usually on their mobile phones) when entering public places or travelling on public transport. Only people with a green code were allowed to travel freely, while people with a yellow or red code were required to be quarantined (Sun and Wang, 2022). Older people reported eight themes about the use of the Health Code. In summary, older people needed some help with the initial use, found the Health Code useful and easy to use with some difficulties, and believed the use of the Health Code is for collective interests with few concerns about personal privacy. Their attitudes also related to the material foundation and the platform of the Health Code, paper certificates as an alternative and policies.

Initial adoption with coaching

Older people's initial knowledge of the Health Code came from news or word of mouth. When it was just launched, older people observed that their young family members could quickly grasp the use of the Health Code, whereas they were confused by the lack of instructions. They naturally labelled the Health Code as "something new and alien" and associated it with young people. When they were forced to use it for travel, they had to find ways to "learn" it.

> *"As an older person, I was not very skilled at first with something as new as the Health Code. I was using it slowly." (Female, 65+)*
> *"They notified us to use the Health Code without specific instructions. Young people managed to learn it by themselves, but we couldn't." (Female, 70+)*

Some older people also remember interactions with their children or staff in public places. Young children and staff behaved like coaches and experts,

providing assistance for older people in their use and dominating the distribution of technology and relevant knowledge.

> *"My mobile phone was redistributed to me by my daughter, and Alipay was also downloaded by her." (Male, 75+)*
> *"At the beginning, I found it really hard. I needed to fill in several forms in Alipay, and it then redirected and redirected again. My daughter helped me to set it up." (Male, 65+)*
> *"I didn't know how to use it at first. When I went to a shopping mall, the staff there were offering help, and I asked them to set it up for me." (Female, 70+)*

Many older people reported a sense of unfamiliarity and demand for help when using the Health Code for the first time. Once the cumbersome steps were completed, however, the Health Code could be activated with only four clicks, or one click with a shortcut, and older people described their subsequent use as "becoming familiar" and "smooth". This showcases a greater difficulty of older people in the initial use of technology than the subsequent use, which indicates that the starting steps of the technology may not be age-friendly.

Usefulness and ease of use

From 2021, the functionality of the Health Code continued to be updated, added with the vaccination certificates and the results of nucleic acid tests. Interviewees tended to believe they were convenient and useful features, as checking this information in public places allowed for quick control of people at risk and it was an effective way to protect themselves from infection.

"The Health Code is handy for me. It shows where I've been and when I had the tests. They are always available on my phone and are always accurate. I'm used to it." (Female, 70+)

Although many older people became accustomed to the use of the Health Code, a proportion of older people still emphasised some inconveniences, including annoyance at the extra steps to access public places and unfamiliarity with the internal logic of the application.

"It's a waste of time to get your code ready wherever you go." (Female, 60+)

"My wife and I are sharing an account on Alipay, and it's a hassle to switch between two codes. I could not always remember the process." (Male, 75+)

Wang (2023, pp.135-136) found that it is very common for Chinese older couples to share the use of mobile phone apps because older couples are always together. However, from this quote, such interdependence of technology use may also cause problems for older people, or technology developers do not seem to consider the difficulty of switching between accounts.

Older people also expressed their dissatisfaction with the emergence of new procedures following changes in epidemic policies.

"When I go to the hospital, I only need to show the Health Code before, but now I have to scan the QR code there[12], sometimes to show the

[12] It is called the "venue code".

travel code[13]*, the vaccination certificates, and even the negative results within 72 hours. When I'm out without my reading glasses, the tick box on my phone is too small to read, and I have to ask for help." (Female, 70+)*

The above quote suggested that older people are not as skilled with smartphones as young people because of poor eyesight and clumsiness. If they are not proficient at first, they could be resistant to the technology, and troublesome procedures may also increase this resistance. The complexity of technology does not make older people learn more and have more skills but may further worsen the vicious circle of intergenerational gaps.

Collective interests

Older people in China generally had an attempt to balance the possible troubles and health security brought by the Health Code. Some people struggled to convince themselves that the Health Code was a good thing and they put this as the premise when considering other issues, because of "governmental regulations", "collective interests" and "health for all". For example:

"It's a bit of a bother, but we are always considering more for our health, and the government is doing it for our good." (Female, 70+)

"We are actively responding to the national policies. We have to comply with the regulations, even if it brings some inconvenience." (Female, 60+)

Older people's willingness to go along with "collective interests" can be attributed to two reasons. On the one hand, it was difficult to control the rapid

[13] The travel code (Xinchengka) is in another app to show travel records.

spread of the virus in China because of its large and dense population. Older people believed that the use of big data to monitor all people should be a relatively easy measure for the government. On the other hand, the government was strict in management to uphold the cultural tenet of safeguarding the lives of older people, and this rhetoric was widely applied by the mainstream media in China during the epidemic.

> *"The Health Code is a tool for the government to manage the epidemic and we as citizens should obey the rules and avoid complicating the situation. Chinese people always put life on top, and this deep-rooted belief differs from the West... The strict management is therefore understandable." (Male, 65+)*

Few concerns about privacy

Chinese older people did not comment much about privacy in interviews, which is similar to the findings of health app users in the pilot study. None of them actively mentioned privacy concerns. When asked if they were worried about the collection or misuse of personal information, they also expressed a predominant view of "no worries".

> *"There was a little bit of apprehension at first... But then everyone was using the Health Code and it became a social necessity. There is no need to think more about data disclosure." (Male, 60+)*
>
> *"The personal information will not be leaked, and I don't feel I filled in any private information. Compared to privacy concerns, I would say it's more important to find close contacts through big data." (Male, 70+)*

These ideas of collective interests over individual privacy among Chinese older people echo Rose and Blume's (2003) point about the use of technology as a means to actualise the potential as "good citizens". That is, when users incorporate citizenship into technology acceptance, the use of technology becomes a civic responsibility, and the state and social policies become important actors in the technological network. This idea will be further developed in the discussion chapter.

Smartphones and the Internet as the material foundation

The use of Health Code is structured on smartphones and the Internet. As the Health Code became a necessity for travel, it also placed new demands on phones and mobile networks. Some older people were unable to use the Health Code because they did not have a smartphone. This further led to the inability to use public transport, as a technology-driven inequality.

> *"Once I went downtown, I found that young people were all using their smartphones to show the Health Code. I don't have a smartphone and was refused to take the bus." (Female, 75+)*

Some older people had relatively old smartphones. Although the old phones can still meet the needs of daily life (e.g., calling and texting), older people often felt embarrassed when being asked to show the Health Code, because their phones were stuck, and the Health Code displayed slowly. They sometimes did not want to go out because of this predictable embarrassment and even bought a new smartphone on impulse only for using the Health Code. In other words, the mandatory application of the Health Code accelerated the need for older people to update their mobile phones, even if they did not want to.

"My Health Code is not available these days because my phone is stuck. I think it's better not to go out. I've just bought a new phone online and I'll be able to get it in a few days. If it wasn't for the Health Code, I would have this old phone for a longer time." (Female, 65+)

"There were times when the bus was crowded and the people behind me were squeezing up. If I was not ready to show the Health Code, they would rush me to hurry up, which makes me feel a bit awkward." (Female, 70+)

Several older people did not have access to the mobile network because they found it expensive or unnecessary. They preferred to use their smartphones at home via WIFI for functions that require internet access, such as watching videos and listening to music. When they go out, they can only look for other ways to activate it.

"I don't have a data subscription because I would like to save money. If I go out with my husband, I ask him to share the data with me when I have to show the Health Code." (Female, 70+)

However, mobile telecom companies claim that they offer relatively affordable data packages[14]. Therefore, some older people's understanding of the "price of technology" might be different from that of technology companies – the data package is not a physical thing worth spending money on for older people.

Alipay and platforms

The Health Code was initially based on Alipay and later it could also be accessed via WeChat and some platforms developed by national and local

[14] See: https://www.163.com/dy/article/HKM2NBCH0534S1MF.html

governments (Tan, 2020). Most of the older people accessed the Health Code on Alipay, and some conjectured that the introduction of the Health Code on Alipay may be highly relevant to a commercial plan. For older people who had been using the platform, the Health Code capitalised on its popularity and built-in functionality. For older people who had not used Alipay before, the compulsory adoption of the Health Code was seen as a promotion of the platform.

> *"The Health Code makes use of Alipay's functions of real-name authentication, location, and face recognition. I have used Alipay before for online shopping and am quite comfortable with that platform." (Male, 60+)*
>
> *"I just started using Alipay when being forced to have the Health Code on it. I used to think that transferring money in Alipay was too complicated, but now I've completely mastered it and no longer need to take change with me when going out." (Female, 75+)*

Some other people even questioned the platform. They preferred to use the platforms developed by the government rather than Alipay, believing that there was some exchange of benefits involved. This complements older people's considerations about the commerciality of technology companies, as do the findings of Walshe, et al. (2024) on the public, which I have discussed in the literature review.

> *"Alipay turned out to be a financial platform. I felt uncomfortable putting my money there, so I didn't use it. I have no idea why the Health Code*

has to be tied to Alipay. When the Health Code was available on the 'Zheliban' app[15], I felt much better." (Male, 85+)

Paper certificates and stigmatisation

When the Health Code was first introduced, it seems that the group of older people without smartphones was not considered and this resulted in a series of incidents of inequality, for example, older travellers without the Health Code were denied access to public transport, seriously infringing their rights (Liu, et al., 2021). In response to this situation, printed versions of the Health Code were introduced a few months later.

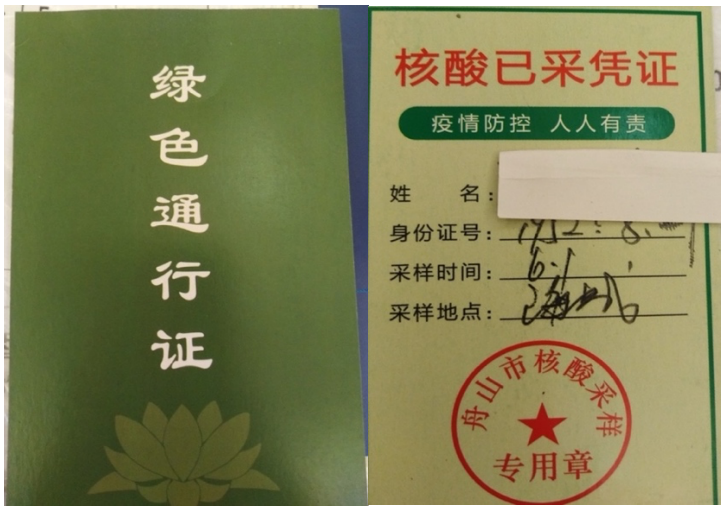

Figure 4: The green pass and COVID-19 test certificate

Among the 30 respondents, there were eight, all of whom were over 70 years old, mainly used paper certificates instead of digital codes. They described their perceptions of the paper certificates.

"I applied for the green pass and vaccination certificate in my residential community. They should be renewed every six months. I

[15] It is the app of the General Office of the People's Government of Zhejiang Province.

also have a stamp every time I take a nucleic acid test. I just need to show them to the driver when I take the bus. It's easier than using the mobile phone." (Male, 70+)

"I'm too old to use a smartphone and I'm using a feature phone. The residential community provides printed cards of the Health Code for older people. Now I just need to take the card out from my pocket to show it, unlike the phone where you have to tap around." (Female, 80+)

Some older people pointed out the problems they encountered with the paper certificates. It did not work on some sites and still created access difficulties.

"The paper certificates only work on the bus. I still have to use my mobile phone or ID card when I go to the hospital. Then I have to carry both when going out." (Female, 70+)

Older people who insisted on using the mobile Health Code raised some concerns about paper certificates. They commonly associated the use of paper certificates with being "old" and "uneducated" and tried to distinguish themselves from those who were using paper certificates. Therefore, they tried to demonstrate an identity of being still "young" and "up to date" by using the digital code. However, there were also respondents who were willing to use paper certificates but were discouraged by the staff of the service centre.

"Our neighbour is using the card and usually hangs it onto her body. I would feel embarrassed if I used the card because I'm still young enough to use a smartphone. People who do not use smartphones have an image of being backward, not well-off and dull." (Female, 65+)

"I did not get used to the Health Code at first and would like to get the paper certificates from my residential community. But the staff there rejected my request. They said, 'You are still young and have a smartphone, so you should just use your phone instead of the card'." (Female, 70+)

These discourses about paper certificates exemplify a stigmatising association. Although the paper certificate was launched to facilitate older people, it also classified users with different forms of code, which made some older people feel uncomfortable. This points to the need for greater consideration in the design of technology alternatives (as well as the technology itself).

Infrastructure and policy

There was also a great deal of discussion around the epidemic policy and infrastructure issues associated with the Health Code. The first is the restriction on travel. In 2022, although China adopted a relatively relaxed policy of "dynamic zero-COVID" with normalised COVID-19 prevention and control measures, many areas were still under semi-lockdown because they were marked as "medium-high risk regions". All people living in these areas were required to have a negative result within 72 hours (or 48 hours) before they could enter public places. As a result, many older people continued the idea of "avoiding going outside if it's non-essential", which was advocated in the early days of the epidemic, for fear of any troubles brought about by the Health Code.

"We used to take a walk and go to the supermarket every day, but now we don't go out as much and prefer to stay at home." (Female, 70+)

“The Health Code is checked everywhere. It’s too annoying for me to take the test every three days, so I don’t go grocery shopping anymore.” (Male, 90+)

Some older people further expressed their views on some unreasonable policies and complained about the constant change of policies over time.

“Some older people who don’t go out at all and barely move around are also forced to have the Health Code checks, which I don’t think necessary. This one-size-fits-all policy is a waste of money that could have been better spent on improving the lives of older people.” (Female, 70+)

“The policies are varied every year. Last year they were checking the vaccination certificate and this year is the result of the nucleic acid test... For older people like me, sometimes we could not catch up with technological updates and policy changes.” (Male, 65+)

In a focus group, a representative concluding statement was made by an older person who preferred to maintain his stable life amidst technological developments and policy changes. He was not for or against technology-related policies, only interested in what is good for older people and arguing that older people should be more responsible for their own health, regardless of whether technological disturbance would persist.

“I didn’t take the vaccine. It’s a bit risky as I’m getting older with geriatric diseases. No matter how technology-related policies change, the most important thing for us is to be more careful and attentive to our health.” (Male, 75+)

The policy associated with the Health Code was rescinded in December 2022 and I returned to some older people to ask if their views on the Health Code changed after that. Most of them showed understanding towards the change of policy and reduced their support for the necessity of the Health Code, noting that the regulation was too tight before and more about economic development than public health. This reflects attitudes towards technology may not be exclusively about technology but are co-constructed with policy – technology can support the development of policy, while policy changes also shift the perception of technology.

5.3 Digital Health Devices

Digital health devices were the second most mentioned health technology among older interviewees in China. About half of them were using digital health devices at home, and some non-users also expressed their views on these devices. Digital health devices include blood pressure monitors, blood glucose meters, smart scales, etc., some of which have WIFI or Bluetooth connectivity and can be paired with a smartphone or smartwatch, or automatically upload health data to a specific platform. Older people's perceptions of these devices covered the following six themes: motivation, complexity, frequency of use, accuracy, post-use effects and non-use.

Motivation and sources of purchase

According to the respondents, the purchases of digital health devices were either made by themselves or assisted by others. Older people's motivations for self-initiated purchases were varied, including having relevant underlying health conditions, for the sake of convenience and daily health monitoring.

Having relevant underlying conditions of one's own or a family member triggered the most demand for purchase, for example:

> *"I bought my own blood pressure monitor and glucose meter after I was diagnosed with a bit high blood pressure and blood glucose so that I can measure them by myself at home." (Female, 70+)*
> *"I've just bought a new blood pressure and heart rate monitor to replace the old and broken one. It is similar to the ones used in the hospital. I bought it online for my husband because he has high blood pressure." (Female, 60+)*

One person explained the change in the measurement scenario, namely that purchasing the devices allowed him to take measurements at home whenever he wanted without having to bother someone at a professional facility as often, greatly increasing convenience.

> *"I have had high blood pressure for more than ten years. I had to run to the health clinic to take my blood pressure before, but when I got my own device, it became much more convenient." (Male, 75+)*

A small proportion of healthy older people identified their need for prevention and self-management.

> *"As I'm getting older, I feel that I need to take more care of myself. My friends referred to these devices and I also read about them in the newspaper. I find that they could enable me to know my health better, so I bought a blood pressure monitor and a smart scale." (Male, 60+)*

The purchases assisted by others were roughly equal in number to purchases initiated by older people themselves. Other purchasers were mainly older people's children and partners. Older people said that they were generally satisfied with those purchases and gifts.

> *"My son bought this blood pressure monitor. He was using it so well that he bought one for me too." (Male, 95+)*
> *"There is a history of high blood pressure in my family. Once my sister fainted because of high blood pressure, my daughter bought me the monitor, so that I can take the blood pressure regularly to control it myself." (Female, 60+)*

Interestingly, when asked who bought the devices, the first response of the older people above was also "I bought it myself", but after carefully recalling the situation of getting them, they corrected this answer and confirmed the role of their children or partners. One of them commented on this that he thought what was bought for the family should just be his own purchase. This may, to some extent, reflect the independent technological identity that they tried to demonstrate and the family-sharing ownership of health technology.

Ease of use

Most older people found digital health devices easy to use. They briefly described or showed how to use their devices, suggesting that the operation and buttons were intuitive and that they did not have many problems using them.

> *"Measuring the blood glucose has only three steps: poke the finger, a drop of blood, and then the value is displayed on the screen. It's very convenient." (Female, 70+)*

"It's very easy to use even though I didn't read the instructions. Once I plug it in, the device would purr, and the values come out in less than one minute." (Female, 65+)

Only two people mentioned the small troubles they had encountered in using these devices.

"The only issue was to use it properly, with the arm parallel to the heart. If you don't have the right posture, the value will be wrong." (Male, 75+)
"I used it regularly when I just bought it, but now I'm too lazy to take my blood pressure. I just find it a bit of a hassle." (Female, 70+)

Although some devices could be connected to the internet to upload health data, older people still tended to use pens to write down the measured data in notebooks, or to simply turn off the devices once they know that the value is normal. Very few of them have fully developed the functionality of these devices.

"I record my blood glucose in a small notebook after I take it. I don't know how to upload data to my phone." (Male, 75+)

This is consistent with older people's use of ICTs such as smartphones and laptops, as they are more likely to use only basic and familiar applications and are unaware of or uninterested in the "advanced features" (Selwyn, 2004). More precisely, older people hope health technology fulfils their preconceived purposes but have little interest in exploring it, which reflects a contradiction between development and demand.

Frequency of measurement

The frequency of use of digital health devices fell into two categories: regular measurements and irregular, sense-based measurements. The frequency of measurement also varies among older people with regular measurement patterns.

> *"I usually take the blood pressure once a week or so, quite naturally, when I think of it." (Female, 60+)*
> *"I am diabetic, and I take the blood glucose at a regular time every day. If I notice any fluctuations, I will take another test." (Male, 75+)*
> *"I take my blood glucose once a week and blood pressure every two days. I will change my medication based on the test results – when it's cold my blood pressure may get higher, and I need to take more medicine. If I change the amount of medication, I will take a few more measurements to verify the effectiveness of the medication." (Female, 70+)*

Some other older people said that they were not using the devices regularly. Although they had the devices at home and found them easy to use, they often did not remember to take measurements in their daily lives. Only when they felt unwell would they retrieve the devices from some inconspicuous place in the house to confirm that their discomfort was due to an expected cause. Zuo, et al. (2020) attributed the infrequency of use to difficulties in remembering and implementing in clinical practice.

> *"I don't usually take my blood pressure. The only time I take it is when I get dizzy and wonder if it's caused by high blood pressure. I put the monitor away in a drawer when I don't feel sick." (Female, 65+)*

However, this woman also reflected on her use and felt a need to take regular measurements as she was getting older:

> *"I actually agree that at my age now I should get into the habit of taking my blood pressure regularly to prevent diseases in advance and to be responsible for myself." (Female, 65+)*

This reflection exemplifies her ambivalence of whether "health" is evidenced by self-feeling or data. This may be a conceptual update brought about by health technology, and it is also shown in the non-users' comments on digital health devices below.

Accuracy and updating of devices

When asked about problems with the devices, most of the older people said everything was fine, with a few mentioning problems with the accuracy of the devices. They believed that most of the accuracy problems were due to system errors or broken parts after prolonged use. They usually did not bother to repair the devices when they were inaccurate but rather sought to buy new ones or just simply abandon their use.

> *"My first blood pressure monitor was not very accurate after being used for a long time, then my daughter bought me a new one." (Female, 60+)*
> *"I used to be taking my blood pressure, but now the device is not showing well. My blood pressure is normal anyway, so I have no intention of buying a new monitor." (Male, 70+)*

Another participant reflected on possible misconceptions she had when judging the accuracy of the devices, but as she had already purchased a new monitor and was using it properly, she still discarded the old and "inaccurate" device.

> *"I felt that the value displayed on my first blood pressure monitor was not accurate. Every time it was much higher than the value I got from the pharmacy. I thought the monitor was broken and bought another one. However, later I thought it might be because I was not taking the measurements at the same time – my blood pressure can be different in the morning and afternoon, so it might not be the fault of the monitor." (Female, 70+)*

The different choices made by older people in updating their devices reflect on the one hand, the shift in user identity, as older people are not necessarily stable users of technology; on the other hand, the preference for replacement rather than repair implies that older people may not care much about the price of new devices. This point was also confirmed by an interviewee's statement of a change of attitude with age when considering the purchase of health devices. She felt in the past that she was healthy and did not want to waste money on health devices, but now she recognised more needs in health management when she became better off financially. Therefore,

> *"If I need them, it doesn't matter how expensive they are. Now I think less about saving money but more about my health." (Female, 65+)*

Post-use effects

Older people always compared their measurements with standard values after using the devices, resulting in either "normal" or "abnormal" conclusions. The

two outcomes created different psychological conditions and perceptions of the devices. “Normal” results made them feel reassured and led to more awareness of their health status.

> *“It’s reassuring to see that the values are normal after the weekly test.” (Female, 60+)*
> *“Sometimes I feel dizzy, but if my blood pressure is tested normal, I will feel relieved. I will turn to think if the symptom was caused by something else, like being tired, or not sleeping well. They are not a big deal compared to high blood pressure.” (Female, 65+)*

When getting “abnormal” results, older people would convince themselves that it was “not serious” and try to calm down and avoid anxiety. They also saw it as a reminder and would change their lifestyle and eating habits in order to be healthy.

> *“Geriatric diseases are common to people my age. Our blood pressure and blood glucose are always a little bit higher than young people. When I see my blood glucose higher than the standard value, I will pay a little bit more attention and eat fewer sweets.” (Female, 70+)*

However, going to the hospital and consulting doctors were not their first choices, as they believed that the “abnormal” values could be improved by their own efforts without professionals. Going to the hospital was seen by older people as a “big thing” and consulting a doctor could increase stress and anxiety and be even considered inauspicious. Siu (2021) also found older people attached such “unlucky” symbolic meanings to hospitals and had a distrust of hospitals and doctors. The distrust is also related to their idea that

hospitals are financially orientated, which potentially contributes to their adoption of health devices at home.

Non-users: reasons for not using

Several older people indicated that they had no intention to buy a digital health device, either because they perceived themselves to be relatively healthy and not requiring frequent measurements, or because there was other equally convenient access to measurements, so they did not need to have their "own" devices.

> *"I don't take measurements at home because I can do it easily at the community healthcare centre[16]... It's all free to take blood pressure, blood tests, eye tests and so on. I always drop by there on my way out... Some professionals would explain the results to me, which is better than taking the measurements myself at home." (Female, 70+)*
>
> *"My blood pressure and blood glucose were normal when I took the tests in the hospital. Sometimes when I visit my mother to take her measurements, I also take mine. I think it is enough, so I didn't buy one for myself." (Male, 60+)*

They further mentioned the possible reasons for them to be healthier than older generations. Compared to even older generations who were economically disadvantaged and had to intake more salt with rice, they have a light and well-balanced diet and are less prone to getting "the three highs"[17]. Therefore, they may not have much need for health devices in later life.

[16] Community healthcare centres in China are similar to GP services in the UK, but they have not yet been popularised.

[17] It is a common saying in China, which is a combination of "high blood pressure/hypertension, high blood glucose/hyperglycaemia and high blood lipid/hyperlipidaemia".

Other reasons for not using were occupancy and intrusion. Occupancy refers to the physical occupation of living space by technology.

> *"I prefer my home to be tidy without any unnecessary tools or instruments. It's too cluttered to have things in the house that I don't use often." (Female, 60+)*

Intrusion refers to the impact of the proliferation of data on the minds of older people. Some participants preferred peaceful lives and to "let nature take its course". They argued that having too much data was not a good thing, but rather an annoyance and a reinforcement of their psychological burden.

> *"I don't have any health devices at home. I'm pretty clear about my own health status. If I had to worry about health values every day, I would be so annoyed that I couldn't even live well. We don't need to compare these indicators with those of young people, just like old cars whose parts break down naturally could not be compared with new cars. We can still use old cars and we older people are still able to get by." (Male, 70+)*

This idea is similar to those who had irregular measurements, while non-users were more convinced that health was a sense of self. Acceptance of ageing as a natural process shaped negative attitudes towards health technology, which corresponds to the co-production formulation in section 5.1, and data-induced anxiety may further act on this process.

5.4 Health apps

Respondents in China had very limited health apps installed on their phones, with the majority using only step-tracking apps and apps for telemedicine launched by local hospitals. Very few were using health apps for sleep and diet.

5.4.1 WeRun and AliSports

WeRun was the most recognised health app among older people, which is actually a subsidiary plugin of WeChat rather than a standalone app. It requires reading the step count data from the pre-installed health app bundled with the system ("Health" for iOS for example) to create a log for exercises and step rankings of friends on WeChat. The interface of WeRun also displays options such as "donate steps" (will be explained in a later section), "send to chat" and "share on Moments" to combine health and social functions. Alipay has a similar plugin called "Sports", but it was used by fewer respondents than WeRun. I identified three themes around the two step-tracking apps.

The datafication of exercise and health

Similar to the findings of the pilot study, respondents reported an increased awareness and motivation for exercise by using step-tracking apps. Just like checking WeChat messages every day, checking step counts and rankings among friends has become a habit for many people. They acknowledged the need and even reliance on data, and some would like to have more data available, such as walking speed.

> *"WeRun gives me an idea of how much I am exercising. I feel that it has raised our awareness of exercise. More older people are enjoying walking now to maintain health and are motivated by these data." (Female, 60+)*

“Without WeRun, I couldn’t have known how much I walk each day. Now I would prod myself to exercise when I see that I walked less... It would be even better to know how fast I am walking.” (Female, 60+)

Conversely, for those who already had a walking habit, such as having a regular daily walking route or having a target of walking 10,000 steps per day, they used WeRun to sometimes reduce the level of exercise if they found that they had already walked a lot in other daily activities.

“I usually walk three laps in the neighbourhood for about 50 minutes after dinner. I used to count the steps, but now I take my phone with me and check the step count on it. As I am getting older, I am using it to control myself from walking too much.” (Female, 65+)
“I know my step count from WeRun and find it interesting. I used to walk until I felt tired, but now I stop walking when I reach 10,000 steps.” (Male, 75+)

Both increased awareness of exercise and reduced exercise show the conceptualisation of data for health. Older people were quite receptive to this quantifying feature of health apps, as it became an expansion of body sensations and a new health habit. However, a few older people expressed the idea that “data is useless”, as their exercise habits did not change significantly with the use of step-tracking apps. They only considered WeRun and AliSports as a tool attached to social apps and taking their phones with them was just for not missing calls and messages, while step tracking was an incidental and optional function.

Social functions

For some older people, the impact of WeRun and AliSports on social activities was rather more obvious than their impact on their health. On the one hand, as WeChat is a social app, the exercise data was displayed in their circles to reveal certain identities or was hidden by them for a reservation of identities, rather than directly impact their health, especially for those who thought “data is useless”.

> *“The step data did not affect me much. I use it mainly because I want my friends to see that I’m walking quite a lot every day and I’m still fit.” (Male, 70+)*
> *“Sometimes I don’t want others to know I walked less so I would hide the data. Otherwise, if a friend asked me why I walked so little, I would feel ashamed.” (Female, 60+)*

On the other hand, WeRun and AliSports further expanded the possibilities of social contact. Some older people pointed out that “giving a like” to friends in WeRun became a starter for natural conversations with them and it enhanced intimacy with friends.

> *“I would give a like to friends who walked a lot and ask them where they’ve been that day. We now tend to initiate the conversation with step counts, unlike just talking about our lives and children when we met in the past.” (Female, 60+)*
> *“I check the walking steps of my friends every day before I go to sleep. I will give a like back if someone gives me a like. I usually have more than ten ‘likes’ every day, which is quite enjoyable, as if I am ‘punching the clock’ to maintain friendships.” (Female, 65+)*

Concerns about step donation

The concerns about step-tracking apps were usually about the feature of step donation. WeRun and AliSports both have access to public welfare platforms, the mechanism of which is to convert the number of steps into public welfare funds at a certain percentage, with enterprises providing sponsorship and investing the funds in public welfare projects. Some older people saw this as an act of "doing good", but others were not convinced by the mechanism and were suspicious of the commercial inducements of the apps.

> *"I like to use AliSports because there were some programs like 'donating steps to people in need' and my daily steps could be transferred into money. Though it's not much, it feels like I'm doing something good." (Female, 60+)*
>
> *"There is no sense in donating steps. There are a lot of scammers affiliated with these apps and they don't really donate money. Why would it give money? How could your walking help other people? I cannot figure it out." (Male, 65+)*

5.4.2 Telehealth apps

Telehealth apps installed on the mobile phones of older people were mainly the official apps of their local hospitals, whose functions included booking appointments, online consultation and checking test results. Older people who supported the digitalisation of healthcare believed that online appointments and consultations reduced waiting times and greatly increased convenience; while those who opposed it found the apps created inequalities and had mistrust towards them.

Facilitating consultation

The use of telehealth apps was supported by relatively young interviewees with more user experience. They praised the benefits of digital healthcare – online booking could avoid wasting time waiting in hospitals and viewing digital reports could also prevent "extra visits". Especially during the COVID-19 pandemic, when a large number of medical resources were devoted to the treatment of COVID-19 and access to hospitals was limited, respondents pointed out that telehealth apps provided a channel for direct communication with doctors and the possibility of long-term application of online consultations in remote areas.

> *"I could register on the app, choose the doctor I want to visit and just go there at the time of my appointment. It is convenient and saves time. Even if I'm late, I can still cut in line because I had the appointment." (Female, 60+)*
>
> *"During the COVID-19 pandemic, or on remote islands especially, it is a problem for older people to visit hospitals and register with experts... The online platform is beneficial for us to register with experts online." (Male, 65+)*

Inequality and mistrust

Those opposed to telehealth apps were relatively older than the supporters. Most of them did not know how to use these apps and provided experiences of being treated unfairly because of difficulties in making online appointments. They also contested the behaviour of "cutting in line" mentioned by the supporters and believed that the apps created inequality.

> *"These apps might be convenient for those who can operate them, but for people like us who can't, we must be now accompanied by young people to go to the doctors. The staff in the hospital to offer help are*

short-handed, and this instead makes it slower to access a doctor." (Male, 65+)

"After the hospital offered online booking services, there were fewer offline receptions. People like us who are not able to make appointments online have to get up earlier to go to the doctor and wait longer. Sometimes when I was late, all the slots had been taken by online appointments and I had to visit again the next day. We were all queueing equally before, but now online appointments are interjected from time to time and crowd out our appointment." (Male, 70+)

Some other concerns were about the authority of online doctors. Older people thought that the platforms for online consultation were not well developed. They were unsure of how to choose a doctor and felt confused about communicating with doctors online.

"I don't have much trust in telemedicine. If I were to use online services for healthcare, I would ask my son to help me choose the doctor and confirm their qualifications. But I prefer to go to the hospital myself because face-to-face consultation must be easier and clearer than remote communications." (Female, 70+)

Compensation for older people

Some older people affirmed hospitals' attention to them when implementing digital healthcare. They understood that the move to digital healthcare was an attempt to improve efficiency, but also gave their views on retaining the traditional offline services.

"It's hard for us to learn to register online as our brains are not functioning well when getting older, so it should not be compulsory for us to learn. There is now a priority window for older people in the registration area of the hospital and it shows that we are not forgotten." (Male, 60+)

"Although hospitals are promoting automated machines, they still retain paper documents and human services. Now that banking services are completely leaning towards digitalisation, hospitals are running online and offline services in parallel. I hope offline services will not be completely abolished." (Female, 80+)

It can be seen from the supporting and opposing comments above that older people's attitudes towards telemedicine apps were closely related to their digital skills and experience and they created inequalities within the older population. Older people who support telemedicine may think similarly to young people, as they are also the beneficiaries of the technology and the advantaged group in the digitalisation of healthcare; but the opponents believed the equality of access to healthcare was undermined. In other words, telemedicine may be beneficial to some people, but it cannot benefit all older people equally and even leave some older people stranded. The retention of traditional services may be a means to preserve equality, but it is unknown whether the combination of online and offline services will last for long.

5.4.3 Health apps for sleep and diet

A very small number of older people mentioned other health apps that they or their friends were using, including sleep and diet tracking apps. Older people's attitudes towards these apps were generally negative. They believed these apps were useless and even counterproductive.

“A friend of mine said that she could not sleep very well and downloaded a sleep tracker on her phone, which showed the time of deep sleep and light sleep. I don’t understand what the point is of knowing this data. She did not sleep better by knowing it, instead became more anxious.” (Female, 65+)

“I am not interested in using apps to monitor my sleep and diet. I just feel like I’m eating and sleeping well every day, and don’t have to be so concerned about these specifics as I’m not ill.” (Female, 60+)

These comments still showed their ambivalence about data and bodily sensations, as mentioned in the section on health devices; and uncertainty about whether the apps were for health awareness or improvement. I will present the perspective of technology workers in Chapter 8, as they contradict these ideas.

5.5 Smartwatches

Smartwatches were a relatively new technology for older people in China. Though several older people mentioned smartwatches, only a few of them had experience using them and only one was still using a smartwatch at the time of the interview. Older people’s attitudes towards smartwatches were related to their user identities, as the existing user had much more positive attitudes than former users and non-users, who were not interest in smartwatches or thought they had no need for them. The themes of the smartwatch are therefore linked to user identities.

The existing user: positive attitudes with self-regulation

The one who was still using the smartwatch got the watch from a promotional campaign by a company. According to her statement, the company offered free smartwatches to older people aged 80 and above four years ago, and her partner received one at that time for the couple to use together.

> *"I have been using the watch for four years and it still works well. I always carry it with me when I go out and it feels quite good to be able to know my heart rate and how many steps I take each day." (Female, 80+)*

In addition to the basic functions, she also had positive comments on the ease of use and portability of the smartwatch:

> *"There was no manual for this watch. When we started using it, my husband just pressed the buttons randomly and used whatever functions came up. My husband is quite nimble. He taught me how to use it when he grasped it by himself, and then I also found it easy to use."*
> *"It is lighter than other watches and comfortable to wear."*

Three minor issues were briefly raised, but she did not think that they seriously affected her use as she only considered the watch as an aid and would not rely entirely on the measurements and records, so she defended herself at once:

> *"The blood pressure displayed was not always accurate, but it's just fine to know a range than not knowing anything."*
> *"The record of steps disappears by the next day and is not stored in the smartwatch, but that's okay for me."*

"I'm charging it once a day or every two days, but I don't have to do it that often. I just feel at ease when it's fully charged."

The positive reviews from the existing user may be due to that the advantages of free and easy to use outweigh the issues of accuracy and charging. However, technical support was not in place, as the ease of use of the smartwatch depends on user proficiency and the technology company did not provide after-sales services in this case.

Former users: deviations from expectations

Older people who no longer use smartwatches listed many reasons for stopping using these, mainly about not meeting their expectations of benefits, values and price. The first was that their perceptions of exercise or health monitoring did not align with their perceived pre-determined purpose of the technology. For example, one person believed that the smartwatch allows people to get more exercise data and test limits, but he was more inclined to exercise in moderation rather than rely on advances in data. He believed that the key to exercise was mastering the principles and techniques while measuring without a good grasp of the techniques could be spoiling.

"I had a Huawei smartwatch, which can measure blood oxygen saturation and heart rate, but I always feel that the measurement is for challenging the limits. Let's say swimming 3,000 metres, people will look at the split lap time, stroke efficiency and heart rate, but I think it's forcing themselves and over-exercising can be harmful to their bodies... Some people started recording their speed with the watch when they were not yet in the right posture for running or swimming. It's like

recording steps for babies who could only crawl or creep, which is totally no sense." (Male, 65+)

Secondly, the use of smartwatches was considered in most cases to be a "show-off", which was not compatible with the exercise goals of older people. This point confirmed that older people are less influenced by subjective norm and image than younger people when accepting technology (Jo and Hwang, 2021) as mentioned in the literature review – older people do not appreciate the role of adopting smartwatches in enhancing social status or impressing others, but believe it is young people's "fashion".

"Using a smartwatch in many cases is just to show off as if they are professionals. Older people are 'exercising' rather than 'training', and it's pointless to follow the so-called fashion." (Male, 65+)

Thirdly, the effort or trouble involved in access and use was less than the benefit. This idea is exactly the opposite of what the first user thought, and it demonstrates great consideration of the price of technology and intolerance of problems by non-users.

"I used the smartwatch for about six months and then I stopped using it because it was too annoying to charge it every day... Now the smartwatches have more features and I thought of buying a new one, but they are too expensive. A few hundred is acceptable, but I was nearly scared to death when people said it cost more than 3,000 yuan[18]. I don't feel it's worth that much." (Female, 60+)

[18] About £330.

However, despite being quite vocal and critical of the above aspects, they were not worried about data security, which was the same as their opinions on the Health Code, because:

> *"I do not consider my weight and blood pressure to be 'private', so it doesn't matter if they are leaked." (Female, 60+)*

Non-users: disliked, unnecessary, irrelevant and deceptive

Non-users' knowledge of smartwatches came from their observation and communication with their children and peers in use. They tended to associate smartwatches with their long-standing habits or stereotypes, leading to the conclusion that they do not like it or need it and that they would not be active users if they owned one.

> *"I don't like wearing watches in the first place, let alone a more complicated smartwatch." (Female, 60+)*
> *"I've seen my family members using the smartwatch, but if it were for me, I would only use it to tell the time." (Male, 60+)*
> *"I might buy one if it wasn't too expensive, but I'm fine to live without it, so probably I still won't use it." (Female, 75+)*

As they found most of the users were young people, non-users naturally perceived the smartwatch as "technology for young people", especially when it was not used in a way that matched their expectations of benefits, or when certain features were "only designed for young people" and excluding them.

> *"My son-in-law is using the smartwatch and he invited me to try it out once, but I feel this technology is only for young people as it's hard for*

me to understand and operate...Young people do not use these watches for health. They are still drinking and staying up late as usual and will throw away the watch after several months. I'm sure I won't buy it myself since using it will not improve my health." (Female, 70+)

"My grandson has a smartwatch. I don't have one and never thought about getting one. I'm suffering from blurred vision, and I can't read the small words on the watch." (Female, 70+)

Non-users also described their experiences of being sold a smartwatch. Too many commercial promotions aroused alarm among older people, leaving them with the impression that technology companies aimed to make more money rather than to do good for older people, and the companies were even suspected to have the tendency to force higher prices of technology to defraud older people.

"I saw a lot of advertisements for smartwatches, but I sometimes feel that they are unprofessional and money-oriented. They were selling expensive watches and seemed to rip off older people who are ignorant." (Female, 60+)

However, some non-users acknowledged that the smartwatch is a lighter tool to carry around than the smartphone. They believe that smartwatches being tied to the wrist greatly reduces the likelihood of loss or theft. But the premise is that they wanted it to have all the functions of their phones to facilitate daily outings, which means, in addition to tracking steps and recording health data, they also hoped they could receive calls and send messages via smartwatches independently, thus they would not have to carry their phones out.

Such expectations may not necessarily be met, as most smartwatches without eSIM need to be paired with smartphones with Bluetooth and are just like an accessory to the phone; that is, network-dependent functions could only be fulfilled on these smartwatches when they were placed at a close distance with the phone. In contrast, smartwatches with eSIM contain additional expenses (such as monthly packages and data), therefore becoming less attractive to older people who do not want to spend money on them.

5.6 Health technology for ageing in place

Older people also mentioned some health technologies for ageing in place and living assistance, including large-scale health monitoring instruments, sensors (e.g., sensing floors, fall detectors) and robots in healthcare, most of which are not yet widely applied in their lives. A few older people were looking forward to the future of technology-assisted ageing, agreeing that digital technology can somewhat enhance independent living in old age. However, most respondents were not receptive to these technologies because of preferences for human carers, high self-esteem and considerations of economic and social policies.

Equal and relaxing

Older people who expressed their favour of ageing-in-place technology concluded that technology-assisted ageing would likely be more equal and relaxing, and less pricey and troublesome compared with going to a nursing home, supported by their children or hiring a professional carer at home.

> *"I don't like to go to a nursing home. It is like being confined and abandoned by my children. Technology-assisted home care will be more relaxing for me." (Male, 90+)*

"It is too expensive to live in a care home... Human carers can bully older people, but I will not be aggrieved by machines, and it will relieve the pressure of my children to support me." (Female, 70+)

"Some of the caregivers in nursing homes only want to make money. They don't treat older people fairly – they look down upon older people who are poor and childless but flatter those who are rich and powerful. Technology won't be that narrow-minded. It doesn't have to eat and make money and can be more efficient than human caregivers." (Female, 60+)

The above quotes show that the advantages of technology-assisted ageing seem to be largely from dissatisfaction with nursing homes and human carers. They conceived an idealised picture of technology-assisted ageing, though technology may not always be "equal and friendly".

Preference for human carers

Contrary to the above, respondents' preference for human carers was the most cited reason for rejecting technology-assisted ageing. Many older people believe health technology cannot completely replace human services, because human carers are more careful and service-minded. If human carers were thoroughly replaced, there would also be an issue of unemployment, as considered by respondents.

"Robots may not serve as well as human carers." (Male, 70+)

"I prefer to have my children around to take care of me, but now that my children live in the big city... Using health technology to support my life would only be an alternative when there is no one to look after me." (Male, 65+)

“If everyone uses health technology, caregivers will be laid off, as if humans are useless.” (Male, 70+)

Some older people referred to the concept of “caring for technology”, whereby technology is not an independent and self-operating tool, and there are always human researchers and manipulators behind it (Lipp, 2023). One person argued that when it came to the stage where technology is needed to assist her life, she would very likely not be able to operate the technology by herself, in which case human assistance would still be required. Therefore, when health technology takes existing jobs, it may also require the creation of new jobs for management and regulation and new demands on users’ technology literacy (Thimbleby, 2013; Hötte, Somers and Theodorakopoulos, 2023).

“Human services should be available in all situations. For older people, if they cannot operate the technology then how is the technology going to help? ... Technology is developed by people and needs to be operated by people with instructions. Suppose I am thirsty, I have to inform the technology before it provides services.” (Female, 60+)

One person commented that ageing-in-place technology should be research-based rather than applied in real life because China currently has a large market for human care services. The large population base leads to relatively cheap labour compared to small-populated countries, which makes health technology less necessary in supporting ageing.

“I think doing research is necessary for the industry of technology-assisted ageing, as it could be a sign of technological capability for our

country, but popularisation is not the case. Technology might be useful in places with few human services, but not in China." (Female, 60+)

High self-esteem

Some relatively younger and healthier respondents felt that they would not consider using health technology to assist their lives at the current stage because they were afraid of losing independence, being stigmatised and appearing frail by using it, while they still wanted to retain high self-esteem and an identity of being able to take care of themselves. This reflects the potential changes in older people's identities and lifestyles brought about by health technology, and older people's resistance to technology in order to maintain their identities (Astell, McGrath and Dove, 2020).

"People get lazy when they use technology to assist their lives. Being lazy and being comfortable can be two sides of the same coin, but I still want to maintain some independence in my old age." (Female, 60+)
"At my age now I'm still in good health. I don't want to go to a care home, nor accept health technology to assist ageing. If my health was really bad at about 80, I might reconsider it." (Male, 65+)

Unlike the stigmatising association of the paper alternatives of the Health Code, in this case it is the technology itself that makes older people feel stigmatised. Some studies suggested reducing stigma with aesthetic features (Chen, 2020). This can be useful for some technologies that need to be carried outside the home (umbrellas as walking aids as an example in Chen (ibid)). However, as I find that older people do not seem to care much about other people's perception of their use of technology, the stigmatising association may actually lead to their rejection of the "technology-assisted ageing" concept (the concept of care

homes as well). Therefore, reconciling the relationship between older people and technology for ageing in place may need to start with normalising the concept of “technology-assisted ageing”.

When it comes to data and privacy, older people presupposed that they would “use assistive technology only when they are really frail” and prioritised the need for “sustaining life” over “self-esteem and privacy”.

> *“I don’t need this technology when I am still independent; if I did get to a time when I could not take care of myself and need constant health monitoring, privacy and dignity would be secondary issues, because I could only live on technology.” (Female, 60+)*

Considerations related to social policy

Many older people considered technology-assisted ageing as a broad social issue. They suggested that it was not just an independent and autonomous choice for adoption or rejection (like for small digital health devices) but was more like social deployment and associated with the ageing context, the development of infrastructure and economic and social policies. If there is a lack of policy support, technology for ageing in place will lead to inequalities.

> *“I hope it will not be too expensive and preferably the government would support free installation, otherwise only rich people can have it.” (Female, 70+)*
>
> *“The government should support the development and implementation of health technology. As far as I know, health monitoring technology has already been implemented in wealthy families in big cities like Shanghai, but not in small towns where human services dominate... I*

hope these monitors can be connected to the nearby service centres... But this in turn involves the financial resources of the government, because it requires people to manage and maintain." (Female, 60+)

On the contrary, some older adults were not optimistic about the prospects of health technology-assisted ageing. Instead of promoting the development of technology, they would rather like to see more age-friendly policies to be introduced, such as raising pensions, improving services in care homes, and expanding the scope of physical examinations.

"Technology-assisted ageing may not be realistic in this decade. I hope the government would launch more practical policies for older people, such as facilitating public care homes." (Female, 60+)
"Health technology is only for monitoring minor diseases, and what we are more afraid of is getting serious diseases. I think we need more support in regular medical check-ups[19] and it will be better to expand the scope of critical illness insurance." (Male, 70+)

An older person referred to the one-child policy that was promoted during the past three decades, which led to a 4-2-1 structure in most Chinese families and intense pressure on young people to support their older parents (and grandparents). He believed that technology-assisted ageing may help reduce this pressure, but more policies and related services are needed, which could be a long-term process; also, mandatory implantation of technology is not a good way to go, because some regions even don't have the basic technology

[19] In China, free medical check-ups are now unequal to older people retired with different jobs and living in different places, as shown in the literature review and indicated by the interviewees. For example, older people living in cities and retired from government departments or large enterprises usually have more frequent medical check-ups and more free items in check-ups than the unemployed living in rural areas.

(e.g., WIFI and smartphones) yet, and the diffusion of assistive technology may instead widen the gap.

5.7 Older people's participation in the development of health technology

As I stated in the methodology chapter, the interview questions about older people's involvement in the development of health technology were somewhat structured according to themes came from literature, including their experiences, intentions, expectations and concerns about participation. This section will present findings based on these four themes.

Experiences of participation

Two interviewees had experiences of participation in the development of health technologies. One participated in a usability trial and the follow-up seminar on emerging health technologies organised by a technology company and the other was a volunteer for checking the Health Code in public places, who had the opportunity to raise relevant issues and exchange feedback with experts online. They briefly described their experiences. The motivation for participation was found to be an invitation from a friend, or simply to get along when feeling bored. They were not active participants in the seminar or the feedback session.

> *"I was asked by my friend to participate in a seminar related to health technology, and I left halfway through. I found most of the participants were referred by their friends and some of them were not really interested." (Female, 60+)*
>
> *"I happened to have nothing else going on that day, so I went along, but I didn't really offer much advice when I attended." (Female, 70+)*

Both of them suggested that some of the activities were targeted at selling products, which discouraged them from staying there.

> *"The so-called usability trial and seminar was all about introducing the product and asking us to experience it. It was like a sales pitch." (Female, 60+)*
>
> *"At first, they say it is a free experience, but they would charge about fifty yuan after the first month of experience. Some other activities pretended to collect our views but in fact were held to persuade us to buy something. They don't really want to know older people's opinions. They just want to make more money." (Female, 70+)*

As a result, they became vigilant about such events.

> *"I checked the authenticity of the event through various channels before the live sessions online, to make sure the organisers are real experts. I'm old and very afraid of being scammed." (Female, 70+)*

However, they were still looking forward to other participation activities and believed that there was a need to involve older people in the development of health technologies, with the main motivation being to improve the practicality and lower the price of health technologies.

Intention to participate

Of older people without experiences of participation, most were reluctant to participate; a few of them thought it depended on the form of participation; and others did not express any ideas about participation, either not understanding

what participation means (even after being explained) or being confused about how participation would be good for the technology.

Older people who were interested in participation saw it as a channel to communicate with young people about new things. They believed that they should not be too detached from the digital world even if they were old, provided that the technologies were relevant to their lives. Some people were ardent supporters of technology participation, but others felt hesitant about their roles as participants though they affirmed the need for older people to be involved.

> *"If there was an opportunity for me to comment on health technologies, I would definitely be up for it." (Female, 60+)*
> *"I'm quite curious about new technologies, and it will be interesting to be a participant or experiencer. Young people and older generations could have different ideas and it will be nice to communicate with each other. But I'm not so sure about what I can actually help." (Male, 85+)*

Older people who were reluctant to participate gave a variety of reasons, including being satisfied with the status quo, not believing that their advice would work, not being eloquent, and preferring to be passive recipients of technology due to complete trust in technology developers. Some older people were even more negative towards participation, countering that technology could be designed without the opinions of older people, and they just accepted the natural order of being outdated, which is similar to the idea of considering ageing as "degeneration" (p. 116).

> *"The designers of these technological products have already considered older people and I am satisfied that I can use some of them.*

It's normal that I may not be able to handle the technology as I get older, and I don't think I need to make any suggestions." (Female, 60+)

"Those who have used a lot of technology and have more to say should want to attend these activities. I don't know much about technology and don't think I can suggest anything helpful, so I'd rather not participate." (Female, 75+)

"I'm not good at speaking in front of many people and I don't want to get involved. I will just give up if the technology doesn't work very well." (Female, 60+)

Some people provided a further breakdown of the formats of participation in health technologies. They recognised technological participation as a means of bridging the generational gap between younger developers and older people and were very concerned about the specific purposes and forms of participation. They were happy to participate in workshops for older people that would really help with the interaction but were disinterested in the top-down dissemination of technological discourses and advertisements.

"There is a need for young researchers to know more about older people and our living conditions if they are designing technology for us. For example, the placement of new technologies in care homes requires researchers to go there and understand how older people live there. Imaginations do not really work... I think that my decision on whether or not to participate depends on the project and the format. I would not go to an event with only lectures and advertisements; but if it was a workshop and we were listened to by developers, I would be much more interested." (Female, 60+)

Older people's intention to participate in health technologies was also largely correlated with their involvement in political and cultural activities. Most of the older people who were reluctant to participate mentioned that they never commented publicly on the news when they read it on their mobile phones or laptops, either assuming that commenting was a matter for young people or being wary of posting public comments. On the contrary, older people who were more willing to be involved in the development of health technologies were also active participants in other social activities, such as having been a departmental representative during their careers, collecting and conveying opinions from colleagues; or having had other experiences with proposals and smooth communication with local authorities.

Older people's expectations of participation

The expectations of participation were all expressed by older people with a fervent desire to participate. On the one hand, they as individuals expected to solve their problems using technology through communication; on the other hand, they were aware that opportunities for participation were often limited, so they should not simply be independent technology users, but also act as user representatives with a responsibility to deliver feedback collected from a wider group, in which case the expectation for participation was that the technology should be better serve the older population.

> *"If I raised some issues in these events, I definitely want someone to solve them as soon as possible." (Female, 60+)*
>
> *"If I participate as an individual, what I contribute might just be my own ideas. If many people have similar opinions, it would be preferable for the platforms to make some changes... There should also be a process of aggregating opinions in advance of these events." (Male, 60+)*

One person also set out expectations regarding the timing of the implementation of advice:

> *"Of course, I hope they can solve the problems. If they can't, I still want an answer or a deadline by which I am able to see some changes, otherwise, my opinions will be for nothing." (Male, 60+)*

Concerns about participation

Older people who intended to participate and those who did not both had some concerns about participation. The first is that there were still few opportunities for participation, or they did not know whether there were opportunities to communicate with technology developers or experts from relevant departments of the technology system:

> *"We have no chance to communicate with technology companies. We could only give feedback to the government." (Female, 60+)*
>
> *"There was very little contact between the health technology developers and older people other than leaving feedback after purchases, which is already an 'afterthought'. The development department and after-sales service department are often separated, and our feedback could only have a very limited influence on technology development." (Male, 60+)*

Secondly, older people argued that there were no platforms to suit the needs for participation. Drawing on their own experiences, they speculated that the main reason for this situation was that technology companies did not really care about user experience. They observed that technology developers seem to be

confined in a space (or laboratory) for independent research, distanced from real users and unaware of users' needs for building a platform for participation.

> *"I hope we can have better communication with technology companies because there is always something we don't quite understand when using the instruments. It would be better to have multiple channels, such as a specific platform, contact by phone, or with the help of social media – Weibo and WeChat." (Male, 60+)*
>
> *"I was quite anxious when I met some problems with the technology, and I contacted the relevant department only to find that there was a shortage of staff to help. Most people in technology companies focus only on development, while other services cannot keep up with that. If there were good platforms for participation, it would positively impact my adoption of health technologies from the start." (Female, 65+)*

Thirdly, some people addressed the issue of inclusiveness of participation, such as how participants were recruited and how they represented real users. They suggested that the participation activities would inevitably have an unfair distribution of places and that the strong relational links (guanxi) in Chinese culture would exclude the voices of those outside the links, especially older people. Therefore, technology departments would make decisions more in line with the interests of those with higher social status, a bigger network of interpersonal relationships and more power.

> *"If there were useful and influential workshops, it would still not be the turn of old ladies who are housebound like me, and by the time we knew the events, those who had their ways would have already signed*

up. This is one of my concerns for our society, people are relying too much on interpersonal connections." (Female, 60+)

Fourthly, there were also people referring to past experiences of participating in other activities, together with the underlying motivations for participation and the follow-up effects. Formalistic activities made them feel frustrated and the limited effects of participation greatly reduced their enthusiasm to participate.

"There were times when people carried out activities based on what they needed, rather than what we wanted to say. For example, they were going to write a report with a predetermined theme, then we had to discuss that 'need' and were not encouraged to free expressions." (Male, 60+)

"For instance, I am concerned about the price of technology, but the price is more likely to be determined by the government and the market. It will not have an alteration with my involvement." (Female, 65+)

Older people's concerns about participation reveal differences in fundamental status and power between policymakers, technology companies and older people themselves. From older people's perspective, technology participation is dominated by technology companies, while older people not only lack a voice in participation but also lack the opportunities to participate. Therefore, it is necessary to further investigate the role of other actors, especially technology companies, in older people's technological participation.

Chapter 6: Findings and analysis - Older people in the UK

This chapter will present findings about older people in the UK. In the same way as the previous chapter, I will begin by looking at British older people's conceptualisation of ageing and its co-production with health technology. The second to fifth sections are structured according to different types of health technologies mentioned by British older people to determine the factors that influence their acceptance. There are some similarities and dissimilarities in the health technologies mentioned by older people in the UK and China. The reappearing technologies brought up by participants are wearable devices, health apps and health technology for ageing in place, which will be detailed in sections 6.2 to 6.4. In addition, older people in the UK demonstrated some interest in electronic health records and technology for improving mental health, and these will be incorporated into section 6.5 as "other technologies for health and well-being". The final section of this chapter will be devoted to older people's participation in the development of health technologies.

6.1 The conceptualisation of "ageing" and technology acceptance

Similarly, older people in the UK were first asked to describe the biggest changes in their life in the last decade. Their answers dealt with perceptions of ageing, the meaning of being an "older person" and descriptions of life in old age. Different dimensions of the conceptualisation of "ageing" include changes in physical health, family roles, environment, social identities, and mentality.

The physical changes of ageing: declining health and need for care

The changes cited by the largest number of British older people were the decline of physical health that comes with age. Older people found that they had been suffering from an ever-increasing number of health problems with age, including but not limited to inflexibility and difficulty moving their arms and legs, loss of vision and hearing, high blood pressure and blood glucose, arthritis, and being diagnosed with serious medical conditions. These physical changes of ageing led to a shift in their roles from being "carers" to "cared-for". Most older people accepted these changes, albeit with some reluctance.

> *"Well, personally, feeling so much rather older. I've had a couple of health problems myself..." (Male, 65+)*
>
> *"I want somebody to read a book to me. Because I've got a really bad arthritic shoulder, so I can't hold a book with my arm trembling." (Female, 70+)*
>
> *"...as you get older you tend to have to be looking after." (Female, 65+)*

Changes in family roles: the loss or increase of family members

Older respondents reported changes in family members over the past ten years and the consequential changes in their roles. This covers not only the loss of their elders or partners, which obliges them to take on more family responsibilities but also the birth of grandchildren or great-grandchildren, which implies a recognition of their children's adulthood and a vision of the future.

> *"My dad died ten years ago. I lost my mom last year, lost my auntie last year, so quite a few losing people, as to say." (Female, 60+)*
>
> *"My daughter got married, and I now look after two beautiful grandchildren. They're amazing, aren't they? You can feel the future." (Female, 60+)*

The one above believed that she gained a greater sense of fulfilment in caring for new babies. This is somewhat different from Chinese respondents, who considered caring for grandchildren as a “traditionally assigned and obligatory responsibility” and emphasised their “contribution”, although people from both countries agreed that the coming of new babies was a blessing for the family.

Change of environment: moving home

Moving home is also one of the common changes mentioned by older people in the UK. Apart from those residing in care homes, which were not involved in this research, respondents tended to move into older people’s residential communities, developing stable social relationships with older neighbours and close contact with household managers; or to live with their children, which facilitated care by children and care for their grandchildren.

> *“I moved here (note: an older people’s community) last year and met new friends. We like to chat in the meeting room every week.” (Female, 60+)*
>
> *“I now move to live with my grandchildren and my daughters...I watch my granddaughter do her homework.” (Female, 70+)*

The expansion of family members and the change in living environment both created new social relationships for the interviewees, and they generally regarded them as positive changes. Unlike being sent to care homes, which were perceived to have connotations of being controlled and abandoned by family members, they felt that making new friends in the new community provided them with a stronger sense of belonging and happiness. This seems to differ from Chinese older people who prefer to maintain existing relationships,

as British older people have a unique demand for “fresh” relationships. Some older people even highlighted their up-to-date knowledge of emerging technologies obtained from new friends and their shared exclamations and explorations of these technologies.

Change of social identity: retirement

Retirement is the most common social identity change for older people in the UK, which also incorporates early retirement due to changes in work circumstances and policies.

> *“I retired when it was locked down in the COVID. Because the government said over seventies shouldn’t go to work.” (Female, 75+)*

Unlike older people in China with a desire to continue working after retirement, older people in the UK did not express reluctancy on retirement. They just assumed it to be something that happens naturally as they get older.

The psychological changes of ageing: loneliness and comparison

Older people living alone described feelings of psychological isolation. Research showed that loneliness among older people in the UK tends to be associated with household status, health resources and social resources (Victor and Bowling, 2012). Older people reported an elevated level of loneliness related to social resources, such as moving to an unfamiliar environment with a lack of social contact. This echoes the need for socialising among older people above.

> *“I’ve been lonely more since I came here. I sometimes come down and say hello to people, but some of them don’t answer.” (Female, 75+)*

Another noticeable psychological change in older people derives from the comparison with younger people. They endorsed the progressiveness of young people, especially when referring to emerging technologies. Some of them believed that the digital world is created by young people, isolated from older people; but some identified the need to "live and learn" in order to keep up with the changing world.

> *"I think that's mainly from the younger ones in the family telling me about digital things. I leave that to them." (Female, 60+)*
> *"I'm like that, anything I don't know, or if people are incompetent, I will go and find out how to do it myself... We don't always have to be as helpless children to the younger generation." (Female, 60+)*

The co-production of ageing and innovation

A relationship between old age and the use of health technologies can be discerned in older people's conceptualisation of ageing. Firstly, ageing creates an initial demand for health technologies, including a possible need for health instruments due to declining health, a possible need for assistive technologies due to living alone after retirement, and a need to use technology to improve mental health and well-being due to psychological changes.

> *"I think there's a certain time, over 60, things can start happening, deteriorating without you even knowing about it. Having health technologies could be one of the preparations for this." (Female, 60+)*
> *"I just moved in and don't have any friends here. Using technology sometimes fills my life." (Male, 65+)*

However, older people also recognised that they might be slow learners of technology (also because of their declining health and sometimes cognitive skills) and not be able to adapt to a completely technology-driven environment, which reinforces the need for "selective learning".

> *"This modern technology advance is so rapid. We can't keep up with it." (Male, 65+)*
>
> *"When you get older, there's only a certain amount you really wanna know. I will think, why do I want to know all that extra so long as I can have the basics and look forward to anything else there." (Male, 65+)*

Based on the above themes and the corresponding perceptions of technology, I similarly develop a five-factor model in the context of the UK. This figure shows how the possible needs and difficulties British older people have with health technology are associated with their cognitions of ageing.

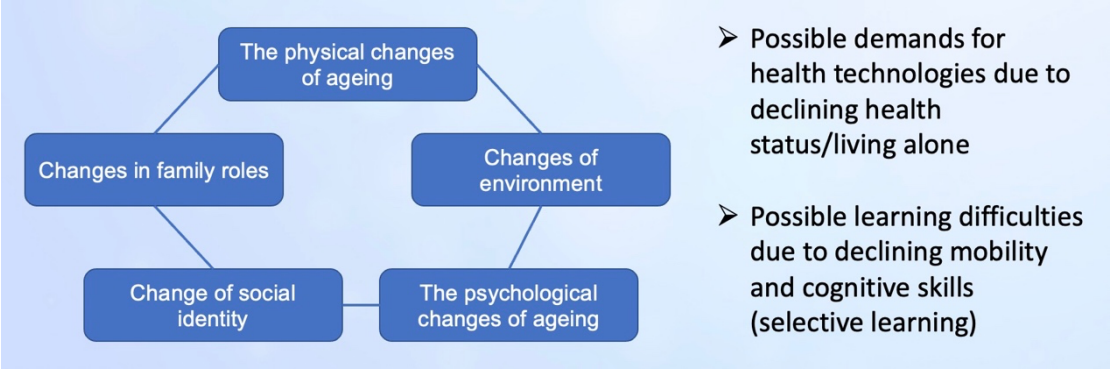

Figure 5: The co-production of ageing and innovation (UK)

Compared with Chinese older people, older people in the UK placed more emphasis on physical changes of ageing (rather than contentment with life or raising health awareness), and the co-production of ageing and technology comes more from this aspect. Older people's perceptions of health technology will be developed more in the following sections by different categories.

6.2 Fitbit and other wearable devices

With the help of the EIDS project (p.104), about half of the older interviewees in the UK gained some initial experience in accessing or using the Fitbit watch, most of whom selected to have it by themselves. Besides, some others also expressed their views on the Fitbit watch or other wearable devices. This makes wearable devices (or smartwatches) the most mentioned health technology by older people in the UK. Their attitudes towards the smartwatch were relatively polarised: some people adapted well to the watch and developed the habit of wearing it and checking health data regularly; while others shelved the watch after a short trial and showed a very strong negative attitude. Their opinions can be classified under the following six themes: satisfaction, lack of usability, help (or independent use), cost, data privacy and accessories.

Expectations and satisfaction

Older people who got a smartwatch from the EIDS project were asked to recall why they wanted it and whether (and in which aspects) it met their expectations. Since those older people were given brochures when selecting the digital technology they needed, their expectations for the Fitbit were mostly from its advertised features, including recording the heart rate, tracking sleep and exercises and getting medication reminders. They hoped to manage their health status in a disciplined way by knowing the health data and having regular reminders.

> *“I want to count how many steps I take. That’s the main thing because I’ve got these mobility issues. I do get concerned slightly I’m sat here for long periods, but don’t have any exercise. So hopefully it’ll give me*

a little bit of inspiration to be able to perhaps just walk down the road." (Male, 55+)

"I would try to get a reminder or something. That's really important for me - the medical alert." (Male, 60+)

"I don't sleep very well, and I want to use the watch to monitor my sleep." (Male, 65+)

Most older people with positive attitudes towards the Fitbit watch or other wearables reported that they were using them "on a daily basis". Active and skilled users (not many) would go further and pair the watch with their smartphones for expanded functions such as data storage (by syncing up in the health app). These older people were generally satisfied with the smartwatch. They believed that it made them aware of whether they were getting enough exercise and would help prevent diseases.

"I use the Fitbit watch every day and I know how to pair it with my mobile phone." (Female, 65+)

"I rejoiced with the Fitbit because I like to move, and I like to know how often I'm moving... You can monitor your movement so it's more preventative. All I've got is my resting heartbeat. And I would like to tweet it to give me a bit more information." (Female, 70+)

Older people's expectations and satisfaction with smartwatches were consistent with older people's focus on practicality found in the pilot study. They had a clear functional orientation towards smartwatches and even tried to develop a full functionality of smartwatches, unlike some Chinese older adults who only use the basic functions of digital health devices. In addition, British

older people's awareness of health seems to arise more explicitly from health technology than from ageing.

Lack of usability

However, there were also many older people who found that the smartwatch did not fully meet their expectations. Some of them affirmed its usefulness in part, suggesting that using the smartwatch can increase their confidence in their physical abilities and in using digital technology, but it could not actually be useful for their health and well-being.

> *"I don't think it's gonna particularly improve my health. It might improve my confidence. It has served a thousand steps a week, then I'll feel more confident in myself. But nothing's gonna improve my condition." (Male, 55+)*

Some people got stuck in the trial and felt overwhelmed and helpless about how to solve the problem. This left them dissatisfied with the technology and sceptical of their ability to use it.

> *"It recorded my heartbeat. It recorded my sleep pattern. But since 4 January, nothing. It just tells me the time. If I go into the app, for the sleep and the heart rate, it says no data... I don't know whether I need to, um, start the premium free trial." (Male, 65+)*

Some others completely dismissed the usability of the smartwatch because they could not set it up or the data was inaccurate. These people had strong emotions when giving feedback, repeatedly emphasising the uselessness of the smartwatch, and even showed resistance when they were asked questions

about “what you like about the technology” and “whether the technology is useful and easy to use”.

> *“It doesn’t work because it gives you the steps when you’re not walking. Don’t use it. Don’t like it. The Fitbit is gonna be thrown out the window... Forget the Fitbit. It’s a waste of technology.” (Female, 60+)*

These people’s rejection of smartwatches points to a possible lack of usability in three aspects. The latter two quotes demonstrate the lack of ease of use and accuracy of smartwatches, which has been addressed in the framework of technology acceptance factors in the literature review. The first quote complements the different understandings of users and technology developers of the prescribed uses of the technology. The user expected the technology to improve health, but the technology may be designed for the cognition of health status – this situation also exists in Chinese older people’s views on sleep apps.

Being helped or independent use

Older people in the UK also showed a very clear polarisation under the theme of “help”. Successful help often leads to smooth use and a positive attitude. In the use of the smartwatch, older people sought help from their children, neighbours, friends and the managers of their residential area. The stages in which older adults needed help were primarily the initial set-up of the watch (similar to the situation of Chinese older people’s initial use of the Health Code) and system updates, possibly suggesting that more effort was required for these two stages than for activating the basic features.

> *“My son is a bit of a techie and has sometimes helped me when I struggle or upgrade things.” (Female, 70+)*

“One of my neighbours set it up for me. If I needed more help, I would ask him again or ask my daughters. They come here once or twice a week.” (Female, 60+)

Conversely, some older adults did not receive reliable help. They said that they were sometimes ignored when asking for help, encountered situations where the managers of the residential area shirked their responsibilities, or where the person they asked for help could not solve their problems. These situations added to their anxiety about using the technology and embarrassment about seeking help. They also indicated that such situations had pushed them to become independent though this was not what they had intended, and they still wished someone to be more responsible for helping with technology use.

“We’ve asked three or four times for people to help us, and we’ve been slightly ignored... And then I think, is it worth saying anything to anybody? Is it worth bothering? So we choose, then, just to keep ourselves to ourselves.” (Female, 75+)

Older adults who were confident in using technology and had high self-esteem tended to learn the smartwatch by themselves. They were always open to new technology and found it interesting to learn new things, not wanting to be defined as “helpless”. However, some of them also acknowledged that they met challenges in using the watch independently.

“I’m a quite well-disciplined person. I don’t need to be taught how to do this or that. If I had something like a wristband, and it told me new things, like my blood pressure, I would be so interested in it. I will go and find out how to do it myself.” (Female, 60+)

“I set it up myself but have problems with pairing.” (Female, 60+)

The first quote shows that older people can have strong confidence in technology, but the confidence does not necessarily lead to successful use of the technology, just as in the second quote, older people can still have problems with use. This may result in a need for extra help and a shift from “independent use” to “dependent use”, which may increase older people’s dependency, or even make them feel older (Caspi, Daniel and Kavé, 2019). Comparing this with the previous paragraph, we can see that there is a fluidity of independence – although one of the aims of health technology is to make older people independent, the need for help (because of, for example, the complexity of health technology) can diminish the sense of independence; available and effective technical support remains insufficient, which rather leads to coercive and unanticipated independence.

Cost

Several older people expressed consideration for the price of the smartwatch. Older people who intended to keep using the watch actively asked about the price they would need to pay if they needed to replace it. They hoped that the smartwatch would last long enough to be worth the money they would pay and had the desire to have the price within a reasonable range.

“The price would be a factor. I would like to buy something that was gonna last ten years and there was a real use of it. Only then it would be worth a thousand something.” (Female, 60+)

“If it’s reasonable I may buy a new one. But if it’s too expensive, then no. I could do 50 pounds, no problem.” (Female, 60+)

Some older people preferred to retain old but still usable products for cost reasons rather than catching up with the latest models, which they believed were more like the habits of younger generations. This again demonstrates that the subjective norm and image have almost no influence on older people's acceptance of technology, regardless of their cultural background.

> *"My tracker is four years old, so I haven't got the most updated one. I suppose that the current one costs a lot more money." (Female, 65+)*
> *"My daughter got one and it's very advanced. Technology is moving so fast and unless you're a millionaire, you can't afford all these things." (Female, 60+)*

A small number of older people said that they did not care about the price of smartwatches and were even annoyed by the question of price consideration because they thought they were "old but not poor" and could definitely afford them. This reflects their preservation of personal identity in accepting technology. Jasanoff (2004) identified the maintenance and redefinition of identity as an important instrument in co-production. In this case, older people attempted to challenge the popular stereotype of older people being poor by stating their affordance of technology. (Older people's attempts to use technology independently is also a challenge of the clumsiness bias.)

Data privacy

In contrast to little privacy concerns from Chinese older people, the topic of data security and privacy protection always came up naturally in conversations about smartwatches with older people in the UK, especially in focus groups. They were not entirely sure how smartwatches would access and use their data but had a great deal of concern.

For example, in one of the focus groups, the topic of privacy came up during the discussion about “the trust in the smartwatch”, and there were two distinct schools of thought. Older people who were wary of data collection first raised their doubts and then were persuaded by another group of people who believed that as older and ordinary citizens their data would not be useful to others and that there would be no consequences if it was leaked.

> *“I don’t trust people, so I switch it off when I’m not using it.” (Female, 70+)*
> *“But you’ve got nothing to worry about because you’re not doing anything dodgy or criminal. There is no use collecting our data.” (Female, 60+)*

This led to a further discussion about what data could be defined as “privacy” and under what circumstances it could be made public.

> *“What you don’t want people to know should be counted as privacy. If I don’t want others to know my activities, I would erase the data.” (Female, 60+)*
> *“But I’m willing to disclose the data for the sake of security and health. For example, I would give the data to my doctor.” (Female, 65+)*

To strike a balance between privacy protection and health management, they brainstormed a “safe mode” on their own, just like the incognito mode in the browser that could be enabled when they don’t want to be tracked, to avoid data history being saved and uploaded. They believed that technology

companies should be responsible for providing such options for users to make decisions about the openness of their data.

Older people who only had briefly tried the smartwatch were unaware of data security, indicating that they needed some actual cases of privacy breaches to pose a risk awareness.

> *"I hadn't thought about it. I mean, I just presume that it was for my benefit. I don't see that anybody would access the data." (Male, 65+)*

The lack of awareness of privacy breaches may also be one of the reasons why Chinese older people did not mention privacy concerns and it may also be related to people's trust in technology companies and the government. The privacy considerations will be discussed further when referring to other health technologies.

Accessories

The use of smartwatches involves some necessary equipment and accessories, including WIFI, charger, instruction, and smartphone for pairing. The inapplicability of these accessories led to a host of negative attitudes, which were not necessarily specific to the technology itself but placed demands on the developers and the environment in which the technology is arranged.

One example is that two people said they could not use the Fitbit watch because it was not an intuitive and simple technology like a switch and the instruction manual was required for a continuous and difficult learning period. As the instructions were too hard to read, they felt frustrated and simply gave up using the watch.

“To be honest, the instructions I got with it were too small. I can’t read it. Unless you’ve got really good eyesight, I suggest that you wouldn’t go to read that. I’m not a stupid person. I’m quite an intelligent person, but I sat here on Tuesday night so frustrated and upset because I can’t get it to work.” (Male, 55+)

I have already pointed out the paradox of older people’s blurred vision and difficult-to-read technology interfaces in other health technologies, as well as older people’s difficulties in operating technology due to declining health. In this case, there is also difficulty in reading the instruction manual. In many technology studies, such issues were attributed to deficiencies in perceived ease of use, but specific to older users, it may imply the problem of ageism. Ageism is commonly defined as stereotypes, prejudice and discrimination towards a person based on their age (Mannheim, van Zaalen and Wouters, 2022). Ageism in technology points to the different needs, lack of communication and power inequalities between older users and younger technology workers about technology, and also technology accessories. I will elaborate further on this gap in Chapter 8 and in the discussion chapter.

Two other people encountered problems with WIFI and Bluetooth connectivity, which prevented them from exploring the smartwatch further.

“Somebody said to me that the WIFI is already in the building but others said I need a box to operate it and pay extra money for that. I was confused.” (Female, 75+)
“I don’t know how to connect the Fitbit watch with the app on my phone. It just told me I need to update, so I didn’t go far.” (Female, 55+)

These issues about technology accessories reveal older people's need for infrastructure and more technical support when accepting health technologies. Chinese older people cited updating smartphones and subscribing to data packages as important foundations for accessing health technologies, while British older people supplemented with the need for WIFI installation, improved instruction manuals and Bluetooth connectivity. Many different actors are required in these needs, including mobile telecommunication operators, network service providers, support teams of technology companies, etc. Problems in older people's acceptance of technology imply the possible lack of responsibility of the above actors and a conflict of interest between older people and these actors.

6.3 Health apps

In addition to health apps that can be connected with Fitbit and other smartwatches which have been narrated in the last section, other health apps commonly used by older people in the UK are apps for medication (including NHS app and myGP), exercise tracking apps, sleep and diet recording apps, and COVID-19 related apps, which cover most of the categories addressed in the pilot study. The following sections will detail older people's attitudes and perceptions of each of these four kinds of health apps. There are both themes already existing in the pilot study and new themes, and the perspective of non-users is also included.

6.3.1 Health apps for medication

Health apps for medication were the most mentioned type of health app by older people in the UK, mainly including the NHS app (the digitalised version of the

National Health Service) and myGP app (the online service of the general practitioner), which has long been at the top of downloads and usage in the app store. They provide services such as access to personal medical information, prescription ordering, medical appointments, online contact with doctors and medication reminders. Older people with great experience of using these apps focused on the advantages of digitalisation of healthcare, while other people pointed out the problems of using these apps, the replacement of personal autonomy and concerns about the privacy policy.

Digitalisation of healthcare as an advantage

Some older people who used health apps for medication recognised the advantages of the digitalisation of healthcare. They appreciated the change from written to digital records in the information age, and from face-to-face to online communication, indicating that health apps can help save time and resources. This is similar to the thoughts of younger Chinese respondents' about telemedicine.

> *"You can get it to remind you to save medications and appointments on your calendars... These functions are helpful." (Male, 60+)*
> *"I do think using health apps for communicating with a doctor is a good thing. I used that service when I got spots from my masks. I changed the type of masks worn, and I used a steroid cream which rid me of the spots. Otherwise, I would waste much time in hospitals." (Female, 60+)*

Problems in use

Conversely, many older people complained about the hassles of using health apps throughout all the steps, especially for online appointment services.

Troubles encountered by older people ranged from not being able to register, not being able to make appointments and having problems when attending the appointments. In some cases, older people found it hard to share the troubles they experienced but described the anxiety and how they made the decision during the process.

> *"I've got the app on my phone, but it won't let me register... I just can't register it, so I haven't used it yet." (Male, 55+)*
> *"I don't know how to make the appointment on the phone (note: said awkwardly). I filled out some personal information in the app, but never received the call back." (Female, 75+)*
> *"Once I made an appointment on the app, but when I went to the GP, they said I didn't have an appointment... I had to ask a staff member there to make it for me and come back another day." (Female, 70+)*

During the interviews, some of these older people told me they had uninstalled the app or left it unused out of frustration and had turned to making appointments by phone calls or visits. Some other people saw the interview with me as an opportunity to get help. They showed me how they used the app and I found that there were problems of personal information being filled in incorrectly, unstable internet connections and no available slots. These problems could be basically due to older people's lack of digital abilities and the complexity of technology; but from a holistic perspective, using technology requires integrative skills (for example, avoiding the above problems and making the appointment successfully requires carefulness and confidence, a good internet connection and the availability of appointments, etc., and the absence of any one of these would result in failure), while older people's grasp of digital skills may be discrete due to their disparities in cognitive abilities and

technological logic from technology developers, and it increases technological anxiety and lead to more time being wasted rather than saved.

Older people who retain some confidence in the use of health apps therefore required a tailored demonstration to follow each step of using the app to better understand what the problem is and how to fix it. This cannot be done by only paper manuals and instructional videos, which were considered too general to meet the expectations of diverse older people.

> *"I would rather pay ten pounds a session to sit round the table with someone that would go through my device and show me the steps to download and register. I want to have a personal tailoring learning session, just like we learnt to drive and use computers." (Female, 60+)*

Replacement of autonomy

Older people who disliked medical apps argued that using the apps for medication reminders could be a replacement and a deprivation of their abilities. There is no need to rely on app reminders when they can remember the medication on their own.

> *"Health apps are replacing part of my brain. If I can only rely on them to remind me to take my medication, it means that I'm absolutely useless. I still want to learn and show that I can do it myself." (Male, 60+)*

The idea that "technology makes people useless" is somewhat similar to the stigmatising associations of health technology for ageing in place mentioned by Chinese older people. In this case, older people's perceptions might be at odds

with the original intention of the design. The medication reminders of health apps may have been designed to expand people's memory as an optional functional supplement, but older people perceived it as a "replacement" for memory. This requires technology developers to pay more attention to the boundary between "help" and "replacement" when designing for older people to avoid stigmatising associations.

Concerns about the privacy policy

In conversations about medical apps, British older people also demonstrated concerns about data privacy, by referring to the privacy policy that appeared when they signed up for the apps. Older people noticed that they always had to tick the "agree with the terms and conditions" checkbox before proceeding, otherwise, they would not be able to use the app at all, so they often gave their consent blindly without knowing how their data would actually be used.

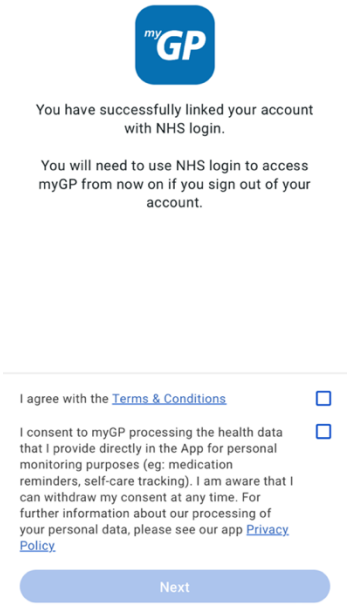

Figure 6: An example of the registration interface for the myGP app

(The button of "Next" is only available when the two checkboxes are ticked)

Older people also mentioned that the terms and conditions of these apps are often not user-friendly, because they are too long to read. This can be even more difficult for vulnerable groups, who may thus have to give up caring about their data privacy.

> *"My friend is very unwell. He's got to the stage in which he has so little energy. He hasn't got to read through the very long security and privacy statements if they exist." (Female, 70+)*

A few older people cited the General Data Protection Regulation (GDPR) as a tool to regulate the use of data, but their knowledge of it was mostly limited to "having heard of it" rather than understanding its practical application.

> *"I've heard about GDPR... but I'm not sure how technology companies comply with it. I have no idea what actions I should take if my health data is misused. I'm still worried." (Female, 60+)*

6.3.2 Exercise tracking apps

Older people in the UK use standalone health apps or apps that can be paired with their smartwatches to keep track of their exercise, unlike Chinese older people, who tend to use the step-tracking feature in other commonly used all-in-one apps. This may be because apps in the UK context are more functionally independent, British older people perform other types of exercise than walking, and there are more British older people using the smartwatch. For these exercise tracking apps, older people in the UK talked about interest-oriented motivations for using them and the issue of mobile phone portability.

Interest as motivations

British older people also identified the datafication of exercise by these apps. They generally agreed that they were motivated to use the apps by an interest in recording exercises with data. Exercise hobbies may not be exclusively related to a desire to stay healthy, but rather as long-lasting habits that make them feel joyful, and they would stop exercising in times of ill health.

> *"I use my smartwatch to record my jog and swim and I have the data in the app. It makes me feel young and happy to see how much I can do." (Female, 60+)*
>
> *"About five years ago I was using an app to record how many miles I travelled on my bike. It was just out of interest... But now I've come to a certain age, I don't feel the need to do so much." (Female, 60+)*

Portability of mobile phones

Older people compared the portability of mobile phones and smartwatches in a focus group. One person thought that smartphones were heavy and that it was not as light as a smartphone to carry and record exercise data. However, another person countered that smartwatches were not portable as well.

> *"The mobile phone is too heavy and it's not convenient to exercise with it... I like the smartwatch more for recording my exercise." (Female, 60+)*
>
> *"But I just think the smartwatch is also too big. And I don't like plastic straps. I find plastic ones to get sweaty. It's very difficult for me to wear all the time." (Male, 65+)*

The gender bias in smartphones has been mentioned in the literature review (Perez, 2019), and here we can see the age bias regarding the weight of

smartphones. Slavov (2021) found that the mainstream mobile phones in the market were becoming heavier, due to the growing size of screens and batteries, which is opposite to the past trend of making phones lighter and smaller. The latest mobile phones may cater more to the preference of young men, but they are obviously not compatible with older people in exercise. To make older people better use health apps, technology developers may need to take the portability of mobile phones into account, and the same goes for smartwatches.

6.3.3 Sleep and diet recording apps

Older people in the UK reported more use of sleep and diet recording apps than older people in China and had relatively more positive attitudes. Most of them were new users of these apps and talked about their motivation for using them and their initial perceptions of usefulness.

Discomfort as motivations

Older people's motivation for using sleep and diet recording apps was often that they had problems in either of these areas. They would like to control their discomfort and improve their health by using the app, without having to bother medical professionals.

> *"My doctor told me that my kidneys hurt with certain foods. I have to be really careful about what foods I eat. There were a couple of times I needed to see a doctor, but not now. Now I use the app to treat myself." (Female, 60+)*
>
> *"I'm just trying to see if I can sleep longer than I am at the moment... I could only sleep four hours a night. I'm just trying to get a bit better." (Male, 65+)*

Usefulness

Some older people affirmed the usefulness of these apps by telling me that they had a balanced diet following the instructions on the app. However, some British older people had similar scepticism to Chinese older people, especially about sleep recording apps. They claimed that these apps did not necessarily meet their expectations for better sleep; sometimes the recording was inaccurate; and in-app purchases were required for sleep guidance.

It needs to be acknowledged that health apps may not be designed as a saviour of sleep and diet disorders. The introductory pages of these apps often describe their functions as allowing users to "understand" (rather than "improve") their sleep and eating patterns[20]. In other words, they may be able to help alleviate mild sleep disorders and control diet to a limited extent but are not able to cure related diseases. Therefore, there needs to be a further investigation into how app developers think and advertise the features of the apps.

6.3.4 Health apps related to the COVID-19 pandemic

The COVID-19 vaccination status service was added to the NHS app in May 2021[21]. In the pilot study, other health apps related to the COVID-19 pandemic (e.g., NHS COVID-19, NHS COVID Pass Verifier) were also listed as the top-used apps. However, in complete contrast to the large number of comments on the Health Code by Chinese older people, British older people showed little experience using the COVID Pass and did not express any opinions about these epidemic control tools. This may be due to the loose regulation and British people's objections to data collection. I will further explain the differences in the

[20] See an example at https://apps.apple.com/gb/app/sleep-cycle-sleep-tracker/id320606217.
[21] See https://www.gov.uk/government/news/more-than-10-million-people-now-using-the-nhs-app.

acceptance of these tools by older people in China and the UK in the discussion chapter.

6.4 Health technology for ageing in place

The discussion of health technology for ageing in place for British older people centred on the fall detector, health assistive technology and home sensors for health use, which were referred to as “health monitors” by some interviewees. Several older people already had these technologies in their homes though not necessarily used them. They talked about the motivations for adopting these technologies, stigmatisation and possible (over)reliance on them, and multidimensional considerations of privacy and security.

Motivations for adoption

Many interviewees found that older adults who owned or installed health monitors in their homes were those who were relatively conscious of their health due to some medical conditions or skilled in the use of technology (e.g., had some experience using digital technology at work before retirement); conversely, older people with high levels of self-perceived health rarely have the motivation to use these technologies and those who used technology less in their daily lives were unaware of these health monitoring technologies.

> *“I have a friend with a heart rate monitor. He might be the sickest friend that I know, and he was an IT expert, so he is very pleased about that monitor.” (Female, 70+)*
>
> *“I am in optimal health. And it never occurred to me ever that I need a health monitor at home.” (Female, 60+)*

Some people further identified the influence of different actors and agents in the adoption of health monitors. For example, one was recommended to use the fall detector by the doctor when some abnormal health indicators were found in the health check-up; and one person argued that technology companies did not make her aware of the existence of health technologies for ageing in place. Therefore, doctors and technology companies play a role in promoting or blocking the use of health technologies by older people.

> *"I actually need to get a fall detector because I've got high blood pressure. My doctor just asked me to get one last week." (Female, 60+)*
> *"I didn't get much aware of these things. I mean, it might be good if doctors or technology companies send us emails or text messages to let us know. Then I can wisely and rationally embrace whatever I might need or reject." (Female, 60+)*

Stigmatisation and possible (over)reliance

The implication of stigma attached to health monitors was also mentioned by many older people. While staying healthy was one of their desires, the use of health monitors may undermine their presentation of "health". They made the point in two ways: first, in their perception, only much older and vulnerable people would use health monitors, but they, as people still able to live independently, should be naturally separated from this group. The picture of existing users' dependence on health monitors shaped a projection of technological stigmatisation among non-users, and they were trying to escape from this scenario.

> *"Well, I know some people, um, my friends, not my age, but older who use these things at home. If they fall down, they press the button, and*

then they talk to an operator... In the end, she kept pressing the button, just to have a chat. So, um, that's funny (note: said in disagreement)." (Female, 60+)

Second, the necessity to use health monitors would only be admitted by older people after a serious accident happened. Any precautionary arrangements of these technologies before that were considered to be wasteful or overprotective, feeling like restraints to the living space.

"It seems that you have to make the commitment in advance of actually having your first fall. I don't want to spend out unnecessarily." (Female, 70+)

"My daughter once asked me if I needed it at home, but I didn't want to be controlled by surveillance while I was still healthy and active." (Female, 65+)

Existing users of health monitors also expressed concerns about too much reliance on the technology, such as feeling unfamiliar with reading and writing after being accustomed to voice control; getting used to reminders and alerts being bad for their brain memory; and becoming burned out on autonomous actions after relying too heavily on health assistance. Concerns about dependence came in part from their observations of their grandchildren using other digital technologies, even if they were somewhat different from health monitors.

"Well, I mean, obviously I love technology to get everything done, but I still want to keep active. If I relied on technology too much, I would diminish as a person." (Female, 65+)

"Years ago, nobody had that technology. It's marvellous for the younger ones today to have phones and computers, but they shouldn't be on them for so long. I'm afraid the health monitors will hurt my eyes and life skills if I do like them, overuse the technology." (Female, 75+)

Privacy and security

There were more privacy concerns for health monitors than for the smartwatch, and more dimensions of privacy were involved. A literature review on privacy distinguished four dimensions of privacy: physical, psychological, social and informational (Leino-Kilpi, et al., 2001), and British older people addressed three of these dimensions when talking about ageing-in-place technologies.

The first is the intrusion of health technology into the physical space, referring to whether older people give consent to health monitors occupying their home and personal space to capture images, audio and video. Some people identified that the placement of health technology in living spaces may require consultation and negotiation with those involved and a process of active or passive adaptation. They were worried about the use of cameras and sensors embedded in these technologies and even cited examples of others who were eavesdropped on to emphasise their unacceptance of constant surveillance and the desire to protect their personal space.

"Essentially there was more work in adapting the space than just installing the monitors. There should be communications with providers and family members." (Female, 70+)

"What's going on in your flat that has access to the Internet, has the ability to tap in to listen. They can even access your camera on your smart devices. I am pretty worried about this." (Female, 65+)

However, participants also acknowledged that they could be monitored for safety reasons and sacrifice some of their privacy, just as it was acceptable for parents to have control over their kids for their safety. This is compatible with the findings of Ienca, et al. (2021) that privacy disclosure did not necessarily discourage the adoption of digital health devices by older adults, who would compare the intervention for safe and independent living with the harms of privacy disclosure, provided they could "retain a sufficient degree of autonomy and self-determination regarding technology use".

> *"I didn't want to be spied on, but it's okay to be listened to and monitored if it is for safeguard." (Female, 65+)*
> *"...just like you've got some children and listened to whom they are talking to. The parental control is for the safety of kids." (Female, 60+)*

Interference with psychological privacy indicates threats to older people's self-identity and autonomy, and it also includes the use of health data by family members to meddle with their personal habits and decision-making (Jaschinski, et al., 2020). Possible threats to self-identity were evidenced through the stigma associations of health monitors. The interference by family members was not obvious from interviews, but a few people acknowledged the possibility of swaying from autonomous determinations in the adoption of such technologies or in making health-related decisions because they thought younger family members should be of more authority.

> *"It's always my son to tell me how to read the data and what it means to me." (Female, 60+)*

Concerns about informational privacy (data protection and integrity) remain a focus for older people in health monitors. They also talked about the possibility of backend systems being hacked and unified in the idea that data protection and management are crucial, but it was not specified who should be more responsible for this.

> *"Once it's uploaded, the data is not just owned by ourselves. I have it in mind that the database involving our personal information might be accessed. It's all too easy to be hacked. We are not able to keep them safe on our own." (Female, 70+)*

Another person raised the possible need for data sharing, reflecting on how her privacy concerns had changed during the COVID-19 pandemic. She argued that sharing information about diseases may help similar cases in the future and that there is no need to be overly nervous about data disclosure, as there were legal regulations to protect personal data.

> *"I probably changed a little bit since COVID. Now I do think it's pretty good to share information. It can do good in academic circles and for doctors. And I think there are laws in protection." (Female, 60+)*

We can see a great deal of privacy considerations from British older people in discussions of smartwatches, health apps and health technology for ageing in place. The factor of privacy considerations was barely addressed in the pilot study, but here it can be regarded as a crucial factor to influence technology acceptance, which may have been underestimated by other studies only focusing on usability. In addition, as British older people have significantly more privacy considerations than Chinese older people, the contextual dimension

can be added to the privacy factor. This difference may be related to privacy education and social systems in the two countries, and the comparison will be further elaborated in the discussion chapter.

6.5 Other technologies related to health and well-being

In addition to the commonly cited health technologies above, a small group of British older people mentioned some other technologies related to health and well-being, including digital health devices, electronic health records and technologies to improve mental health. Older people's discussions of these technologies were somewhat fragmented and could not be developed into themes, but it is worth having some brief descriptions and analyses.

6.5.1 Digital health devices

Unlike older people in China who considered digital health devices to be a popular kind of health technology in their lives, few older people in the UK mentioned these digital health devices – the blood pressure monitor and the glucometer. No one was using these devices, but one person expressed a willingness to purchase a device. A brief conversation about digital health devices happened in a focus group, partly explaining the reasons for non-use.

The older person who wanted to purchase a device liked the preventive role of the devices on diseases, but another person argued that health devices should ultimately be able to cure diseases and free older people from suffering. Since the primary goal of home health devices is not to treat diseases, this reduced her interest in adopting them. This also aligns with older people's demand for sleep-tracking apps.

“I think I would like to monitor my blood pressure when I wake up and after my exercise... It might help prevent serious diseases.” (Female, 60+)

“Healthcare devices are good. I’m going to say that I couldn’t fault it, but I’d rather love somebody say, I found a cure for cancer, for Alzheimer’s... Older people can’t enjoy their life if they are in pain. If healthcare devices could help with diseases, it would be marvellous.” (Female, 75+)

British older people also recognised the role of the government and NHS. The improvement of the healthcare system and the increase in human and medical resources in recent years made it easy to have a basic health check with the community clinic and GP, thus reducing the need and urgency to acquire digital health devices at home. They also did not seem to see going to doctors as “unlucky” as Chinese people did.

“I just went to the GP and took my blood pressure last week. There’s no one, nobody else waiting, and I know I can go in any time and just do it.” (Female, 60+)

In addition, there was a discussion about the functionality of health devices in the focus group, by asking whether they would have a health device for multiple purposes or rather have many devices to monitor specific things separately. Members of this focus group generally agreed that a single-function device could be more accurate than a multi-purpose device, but having too many different devices would clutter the home. As a result, more people tended to pick the option of “one size fits all”, but as existing digital health devices are more likely to have a single function, it may somewhat reduce the appeal to

them. If “one-fits-all” devices were going to be launched, there would also be new requirements on how to minimise the complexity of the devices.

6.5.2 Electronic health records

One person referred very briefly to electronic health records (EHRs). She raised concerns about the monopoly of the electronic system, while expressing satisfaction with paper records, in line with the findings of Young, et al. (2014) I discussed in the literature review. The persona also added concerns about the possibility of data loss due to the breakdown of the system.

> *“I personally go for paper solutions wherever they are available, just because I think if we put all our eggs into one basket technology, and we have no electricity, there’s a system failure or a system hack then, you lost.” (Female, 70+)*

There may be two reasons why older people do not mention EHRs much. On the one hand, EHRs may not have been fully introduced to older people and older people do not have much knowledge about EHRs, when paper records are still available. On the other hand, the decision to adopt EHRs is often not made by the patients but depends on the connectivity of hospitals and clinics with information systems and the government’s promotion of digital healthcare. When EHRs are not available, older people have no way to use them; when EHRs are available, it is mainly healthcare professionals who input medical information into the system and older people have limited interaction with it. However, this does not mean that older people’s views on EHRs are unimportant, as varying levels of access to EHRs can result in healthcare inequalities, and potential users’ concerns about security should also be the focus of technology developers.

6.5.3 Technologies for mental health and well-being

In addition to health technology in the traditional sense, British older people mentioned other technologies that could be used for mental health and well-being, including technologies that expand their sensory and mobility (e.g., Bluetooth speakers that can amplify sound and smart plugs that enable them to remotely control electrical switches), and recreational technologies that make them feel happier and less lonely. These technologies may not have been originally designed to improve mental health, but respondents confirmed the positive role of these technologies in promoting well-being.

> *"My happiness is boosted because I can actually hear things now with the help of the Bluetooth speaker." (Female, 60+)*
> *"I use the Alexa every day. I can now get some music going instead of just watching TV. Music cheers you up anyway, doesn't it?" (Male, 65+)*

Conversely, some older people also talked about the possible deterioration of health caused by over-reliance on these technologies. For example, continuous exposure to loud sounds or noisy environments may cause hearing damage; relying on remote control technology may even reduce one's mobility.

> *"There's a wellbeing thing as well from overuse. The Echo dot helps to turn the lights off and on, so I don't really move a lot." (Male, 75+)*

Compared with Chinese older people, British older people are obviously more concerned about using technology to maintain their mental health and happiness. Descriptions of mental health and well-being did not appear in

interviews with Chinese older people, which points to a possible lack of this component in Chinese culture and education. However, for British older people, compensation for loneliness and depression that come with ageing may be as important as maintaining physical health.

6.6 Older people's participation in the development of health technologies

The thematic structure regarding British older people's involvement in the development of health technology is the same as that of Chinese older people. The following sections will set out the findings on British older people's experiences, intentions, expectations and concerns about participation.

Experiences of participation

Similar to Chinese older people, British older people have very little experience in participating in the development of health technologies, with only one person, other than those included in the EIDS project, having taken part in a usability test of health technology in a university research department. She forgot how she got the information about research participation but was very satisfied with the experience as she received both a reward for her participation and full recognition from the researchers.

> *"I love those things particularly that paid. I used to be involved in a field test for the eyes where you have to pinpoint. It had to do with reaction times – how fast one reacted to whatever the stimulus was on the screen. I was told I did well so that was good. The data they wanted was the quantitative data, not the opinions." (Female, 70+)*

Some older people recalled that they might have been recruited for activities that had some relevance to health technology (may not be primarily for the purpose of getting their input on health technology), but on second thoughts denied their involvement therein, or described the format of the event and asked if it belongs to a kind of participation. Unfortunately, I think it would be a stretch to characterise these events as technology participation, for example, announcements were posted in the reception of residential buildings that a healthcare device would be placed, but residents hardly objected to this.

> *"I may have been involved in the kind of activities you are talking about..... (thinking for a moment) No, I haven't. I know there is some tech-related promotion over here, but I don't really know what it is, and I've never made a suggestion." (Male, 80+)*

Most older adults have never heard of participation in health technology. They imagined it should be good to get older people involved but wondered who would organise it and in what way they would be accessed.

> *"I wasn't aware of any activities I was involved in." (Male, 65+)*
> *"I've never heard that. I mean, there's some things like that would be good, but I don't know anyone has ever proposed." (Female, 60+)*

Older people involved in the EIDS project felt that they attained the initial participation experience in health technology. They thought the free distribution of technology products and the collection of feedback was a good format of technology participation but were not quite sure how their feedback would be used for the update and improvement of technology.

Intention to participate

The majority of older people in the UK believe that older people's involvement in the development of health technology is necessary and demonstrate a relatively strong intention to participate, unlike older people in China. They regarded themselves as active participants if they were aware of such activities and were invited. The reasons for these older people's interest in participating varied and included:

Firstly, some of them believe that participation in technology would be part of building social relationships and that meeting peers and younger technology workers at events would be fulfilling to their ageing lives. These people tend to be enthusiastic and outgoing, enjoying self-expression and listening to other people's opinions.

> *"If there was an opportunity, I would like to be involved. Because I am somebody who is really open to other people sharing. And I talk a lot. I talk to lots of people, even people I don't know on the bus." (Female, 60+)*

Secondly, technology participation is seen as a great opportunity to learn about technology. Older people feel that there are currently few opportunities for both learning technology and participating in technology and that if there is a chance to be invited, they must take advantage of it, or risk being left behind.

> *"I'd be happy to be involved in other things like that. I want to learn more things. If I don't know technology, I'd be totally ignorant about it." (Male, 65+)*

Thirdly, older people find that technology participation can benefit themselves. The benefits come on the one hand from being able to use technology better by having it improved through their feedback; on the other hand, they also expect to receive direct benefits from technology participation, such as discounts on the purchase of new products, payment for the participation, or free access to technology, as in the case of the EIDS project.

> *"I think stakeholder involvement is absolutely crucial with any technology. The more the better. It is one way to make technology better." (Female, 70+)*
> *"I like to come. Just to see what's on offer, what's there, and to see if I could benefit from anything." (Male, 65+)*

Fourthly, some older people consider the benefits that their participation could bring to technology workers. They suggest that it is important and useful for technology workers to listen to the advice of potential users when prototyping the technology. For technology workers, this can be an accumulation of creative ideas, and the potential users can get a head start on the product, generating the possibility of more applications.

> *"I think it's worth to participate because you line in more about that proto. I suppose it's good for them to get feedback." (Female, 60+)*

There are few British older people who do not want to participate in health technology, either because the negative attitudes towards the nature of technology spill over into other activities related to technology, or because of personal psychological factors.

"I think once the Fitbit watches are set all, I will be fine. I don't envisage gaining any more technology or participating in any other activities about that." (Male, 55+)

"I have anxieties. If I go somewhere where I don't know, it sets me off on a panic attack, and I will feel hard breathing." (Female, 60+)

However, this participant also indicated that small-scale social communication was acceptable, such as participating in my interview or a small focus group with acquaintances present, hence the format of technology participation was important to her.

"It is fine if there is only one person like you and XX (the caregiver) is just outside as well. If there is more, I think I will start to panic. Although I've spoken freely today, I actually do find it hard." (Female, 60+)

Given that there may be a proportion of older people with different psychological conditions, it is necessary for those organising technology participation activities to have greater regard for the settings of participation and the way to approach older people, so that older people can express their views freely in a comfortable environment.

In addition, most of the older people considered offline participation without mentioning online reviews of health apps (as in the pilot study) or other online participation as an effective mode. This shows some possible limitations of the review platform. When older people who mentioned health apps were asked about their views on online review platforms, they said that they might make a comment when they had a desire to express themselves, but they generally agreed that it might not be as effective as other formats of participation that

could create direct communication with technology workers. They felt that online comments were easily drowned out in the mass of information and were unlikely to be taken seriously by technology developers. This idea was checked with technology workers in the interviews and the outcomes will be presented in Chapter 8.

Older people's expectations of participation

Compared to Chinese older people, older people in the UK have more proactive expectations of health technology participation, especially those who attend to the benefits of participation for technology workers. They assume that the technology companies and workers (rather than themselves) are the ones who demand their participation, and therefore put forward high requirements on the organisers of the participation (such as having a full understanding of the technology and a readiness to provide participants with frank explanations), as well as high expectations of how the participants' opinions would be taken into account and followed up.

> *"They need to come along not only with their sales pitch but with the facts and be ready to answer questions, and I think potential users need to be primed to ask questions. Their opinions need to be well received." (Female, 70+)*

Older people with a more autonomous and democratic spirit think that technology participation is not entirely dominated by technology companies and experts, but that they themselves can be pioneers among older people in organising technology-related events, in which they require the presence of members of the technology companies, who can immediately respond to and record the views of the participants.

"To be honest with you, I think I can start these events myself. I am doing an online studio now and I will be starting different workshops with not only older people but of all ages, and also with technology developers aside. These workshops will help people to know technology better. I am a more proactive person and I think it is exciting, isn't it?" (Female, 60+)

Several older people also recognise the workshop as an effective form of health technology participation. They may not only value direct communication with technology workers but also the stories and opinions of each participant and enjoy interacting with peers about their use of technology.

"Workshops are always good, because you get to know people in the workshops, and you hear their stories, and it's a bit of solidarity learning about things." (Male, 65+)

Presentations with a Q&A session are also suggested as a desirable form of health technology participation, where the key is to create a connection between the technology workers and the participants, to provide participants with something to take away, and to enable opportunities to communicate again when older people encounter other technical issues, rather than a "formalised one-off performance".

"A presentation would be fine as long as there are opportunities to ask questions, and perhaps even a hand-out at the end with the main points, and the opportunity to be back. I prefer a face-to-face event." (Female, 70+)

Older people would also like to keep the scale of participation small, in favour of everyone involved having the chance to contribute. They hope that the organisers will be good at communicating and lightening the atmosphere to avoid particularly talkative people dominating the participation agenda and drowning out other useful proposals.

From older people's expectations, it can be found that although they also attempted to be the lead participants, more demands were directed towards technology companies and other organisers. This reflects the fact that older people's power as participants may be limited, and they may need to be subordinated to the authority of other stakeholders. The other two groups of interviewees were also asked about their perceptions of and roles in older people's involvement in the development of health technology before their conflicting and aligned interests were integrated into account.

Concerns about participation

Oppositely, British older people were much less concerned about health technology participation than Chinese older people. Their main concerns are self-oriented, as they are afraid that their participation might not be helpful to the development of the technology. They have similar and different ideas from older people who have high expectations about technology participation. They both consider participation in terms of "what will my participation bring to the technology", but their confidence in using and participating in health technology is markedly different. Older people with concerns may have suffered some setbacks in their use of health technology, and therefore seemed to lack confidence in answering questions related to technology, and even resisted responding to issues such as digital privacy and technology policy.

“I don’t really know how my participation will help. I cannot set up the Fitbit. I can’t say or answer something. I don’t know if I’m going to enjoy these events... I’m so sorry.” (Male, 55+)

Some others extend the frustration of technology use into a sense of anger, believing that they think completely differently from technology workers and cannot communicate with them and that technology workers are unlikely to make changes according to their suggestions.

“I don’t know if my participation helps. Like, if you say that the Fitbit is rubbish, do you think some developers would change it in some way? Probably no. Because I want it on my ankle for walking rather than on the wrist, but they can’t sort it out.” (Female, 60+)

There is also concern that participation in technology development would not adequately address their misgivings about technology. For example, one older person commented that if she were to engage in any stages of the development of health technology, the main inquiries of her would be about the provider of the technology and whether she would be able to afford it, but technology participation oriented towards promotion and testing may fudge the answers to these questions and she may not get the desired outcomes, which makes her feel not worthy to participate in such activities.

“I only want to know who provided the technology and how much it is. When something is new, it’s always more pricey... but they may not tell me... it’s just a waste of my time.” (Female, 70+)

British older people's concerns about technological participation reflect their uncertainty, both about themselves and about technology companies. Uncertainty about themselves lies in the situation that they do not recognise themselves as "skilled technology users and participants", which is perceived by them as people with knowledge of technical terms and proficiency in operating technology and communicating their demands, and they tend to regard these as necessary conditions for participation. It has been identified in the literature review that limited skills constraints participation (Bultitude and Dawson, 2011), but this does not mean that non-users (and older non-users) cannot play an important role there. Older people's uncertainty about technology companies (and how their suggestions will be adopted by technology companies) reflects the separation of the perspectives and positions between the two groups. The interviews show that older people portrayed technology workers as arbitrary, and there may be a disconnect of technical stances between the two sides. Therefore, there is a need to ask technology workers how they deal with feedback to further understand the mechanisms and outcomes of participation.

Chapter 7: Findings and analysis – Caregivers

The second group of interviewees were ten caregivers from the UK or China, including people who had been living with their parents or grandparents for a long period with the role of a caregiver, managers and staff of care homes, professional caregivers working in hospitals and the homes of older people. The professional caregivers and those working in care homes had at least two years of relevant working experience. Conversations with caregivers revealed their perspectives on the images and behaviours of older people which were reinforced by health technologies, their views on health technologies (and technology-related issues, such as care responsibilities and technology ethics), and their roles regarding older people's acceptance and participation in health technologies. I have interviewed five caregiver living in China and five in the UK, but it was found that there were no significant differences in the perceptions between caregivers in China and the UK because of their mixed backgrounds and cross-cultural perspectives (will be further discussed in section 9.1.6), so I will not separate the findings of caregivers by their countries or tag their background information after the quotes in this chapter, except for the differences directly mentioned by the interviewees.

7.1 Images of older people as perceived by caregivers

The caregivers began by describing the lives of older people they had been with and their feelings about spending time with older people. The caregivers agreed that the images of older people in their eyes might be quite different from older people's self-perceptions, as older people tend to disavow certain attitudes or disremember some viewpoints they have expressed, sometimes because of the maintenance of their authority of eldership. Caregivers also

found that older people's reluctance to recognise their self-image (or unconscious self-image) was reinforced by new technologies. From the caregivers' perspective, older people are frugal, monotonous and stubborn; they always have extreme attitudes towards health and a strong desire to talk. I put quotation marks for the themes I obtained in the interviews to show that they were the opinions of caregivers rather than an objective summary of older people's images.

"Frugality"

Conversations with older people showed that they were not particularly concerned about the price of health technologies but through the observations of caregivers, many older adults maintained their traditional habits of frugality due to having grown up in a time or region of relative poverty. Caregivers suggested that some older people regarded the purchase of health technologies as non-essential, as their health conditions had not deteriorated to the state where they had to be monitored; and that older people living with them would reject their help in purchasing health technologies, equating emerging technologies with expensive prices, and creating a burden of accepting these technologies.

> *"My parents have no interest in using the smartwatch because they think it is too expensive though they can afford it."*
>
> *"The older members of my family naturally associated technology with high prices so they do not bother to know these things, and even did not let me buy (the smartwatch) for them. Even if it is not expensive for them, they subconsciously think it is."*

This personality or habit of older people gave caregivers a flash of insight into the promotion of health technologies – to reduce the cost that older users need to pay, such as making free trials an opportunity for older people to get in touch with technology and then promoting it to the market after some older users make sense of the need or advantages of it.

> *"Older people may think that using health technology is a waste of money, but if some older people would like to covet little advantages, giving them a free trial might be a good way for promotion."*

To a certain extent, caregivers' perspectives of thinking may be close to those of technology developers (but away from older people), which may be because the two groups are in the same age group and have similar social roles (as promoters of technology), or they automatically assign themselves the social responsibility of paving the way for the use of technology as an inevitable element of current times.

"Monotony"

Several caregivers mentioned the monotony of older people's lives. Erikson's (1995, pp.241-242) stages of psychosocial development describes late adulthood (65 years and above) as a stage of ego integrity in which there is "despair" and "abandonment" because the lifetime left is too short to start another life. Caregivers' statements also corroborated this characterisation of the lives and emotions of older people. They believed that, unlike young people who have a natural curiosity for new things, older people's primary concern is to sustain a regular life and therefore they may perceive the emergence of new technologies in their lives as a threat that would disrupt their existing routines.

“My grandparents’ life is pretty much the same every day. They are out walking by the time I get up, take a nap every afternoon and then go out for another walk in the evening after dinner.”

“Older people living in the care home are satisfied with a daily dose of sunshine, a good meal and some chats with peers. It seems that they do not want to accept anything new – which might be destructive to their lives.”

“Stubbornness”

Older people’s adherence to basic lifestyles and habits can also easily develop into stubbornness and “incomprehensibility” according to caregivers, or a personality trait of “neuroticism” that Wagner, et al. (2016) found to increase with age. Caregivers suggested that older people are highly conscious of social customs and traditional concepts (such as family values and the seniority order), and subjectively recognise and emphasise their eldership, as well as their authority and unquestionability in life affairs. Repeated references from different caregivers imply that this is not an isolated case of a particular older person, but rather a generalised personality change that occurs in old age.

“My grandmother cooked the same dishes every day. I would give her advice, but she had never taken it seriously. For example, I told her to consume less porridge to lower the blood glucose, she would deliberately take more.”

“My mother-in-law always gets angry when I ask her to eat more or exercise more, and she is all the time arguing with me over trivial things. She had a good temper when she was younger but is just getting stubborn in the last few years.”

Caregivers were also worried that older people could be deceived as they are stubborn to “believe only what they want to believe” without listening to the advice of young people and health professionals.

> *“My grandma spent a lot of money on health care and poor-quality products. She was always persuaded by fancy adverts on TV but never trusted doctors.”*

Similarly, new technologies from unfamiliar fields are something that “stubborn” older people attempt to resist. According to caregivers, the resistance is sometimes because of one’s physical condition, but more often it is related to stubbornness. Caregivers said that older people’s resistance to health technologies is usually unreasonable, but simply out of adherence to the attitudes of rejection.

> *“Older people are always reluctant to embrace new technologies. They don’t want to even try it no matter what we say. They hear it and forget it. Instead, they cannot understand why young people are with their mobile phones all day long.”*
> *“A lot of them just keep themselves to themselves. Some of them are unwilling to accept or try new technologies. Even when they started a trial of the smartwatch, they still don’t think they need it and never ask me anything about it.”*

Similar to the threat of technology to older people’s life routines in the previous section, it seems that if caregivers forcefully “shoehorn” technology into older people’s lives and help them use the technology, caregivers and the technology may both become a threat to their authority. In interviews with older people,

they attempted to show this position gently by demonstrating that they were able to use technology independently to maintain their identity, but caregivers seem to challenge older people's authority in a critical tone.

"Extremes in health attitudes"

Older people reported increased awareness of health or passive acceptance of declining physical functions due to ageing. Conversations with caregivers revealed that older people had more extreme health attitudes than their self-perceptions, manifesting in two situations: being overly concerned about health or completely ignoring changes in their bodies. Older people who are overly concerned about their health tend to exaggerate their ailments, remain sceptical of check-up results, want doctors to do more examinations to reassure themselves (even if some examinations are needless), and may have more demand for health technologies. Conversely, older people who ignore health problems would find excuses to avoid going to the hospital, and sometimes they are forced by their caregivers to see the doctor until the later stages of illnesses because they think hospitals are inauspicious and doctors are unreliable. They are often uncooperative with treatment and tend to dismiss the need for health technologies in their daily lives.

> *"My grandma sometimes messes with her mind. She had major surgery last year and always feels out of breath, but she cannot get anything checked out at the hospital. Doctors said that she recovered well."*
>
> *"The older people I spend time with are still healthy and don't think it necessary to do a systematic check-up, even if they have symptoms. They are also afraid of being diagnosed with diseases and fear that the doctor may prescribe useless tests for a commission."*

A caregiver working in a hospital explained the possible reasons for the polarised attitude as being related to the level of education and the living conditions of the older people:

> *"Older people, especially those living in rural areas, can become overly dependent or distrustful of doctors because they are not clear about their health conditions. Older people who are better educated will be more aware of the medication and more likely to accept that illnesses are sometimes slow to heal."*

Attitudes towards doctors here also indirectly reflect attitudes towards health data and emerging health technologies, because according to caregivers, these are externally defined "accurate" and "authoritative" sciences, but older people's self-perceptions are also "internally" accurate and authoritative and when the two are in conflict, a crisis of trust and interaction can occur.

"A strong desire to talk"

Caregivers who have worked with many different older adults also characterised them as "talkative", as some older people who live alone would like to meet their communication needs when they are taken care of by caregivers.

> *"Most older people have a strong desire to talk. When doctors ask about their health, they say a lot of things that have nothing to do with their health, such as what has happened to them recently and their experience of seeing doctors before."*

"The older people I'm currently living with have many mental health problems. It is not easy to settle them down and they are always looking for me and hope to chat with me."

Older people's strong desire to confide or strong ability to communicate with others also indirectly contributes to their resistance to technology. Caregivers pointed out that in previous times, everything was done by communicating with people. For example, when going to the hospital, older people felt that on-site registration and asking staff for information about the medication were commonplace behaviours, so they would consider online registration and consultation "unnecessary" for the reduction of communication. Some young people have trouble communicating with people, especially those who are "socially phobic" or with social anxiety – a fast-growing phenomenon among young people in recent years (Jefferies and Ungar, 2020), and the use of technology could help them avoid some social interactions. However, older people feel that communicating with people in the hospital is not as much of a hassle as learning to use the health technology.

"Young people sometimes are lazy to go out and talk to people and find it easy to use the mobile phone, but older people can always talk to strangers naturally and it is simpler for them to ask people than to use the health apps."

Caregivers' recognition of older people's strong desire to talk may also partly explain some older people's preference that care should be done by humans rather than by health technologies. The empathy and interactivity of human caregivers is an essential part of care as perceived by older people. As it cannot

be fully achieved by health technology at this stage, a complete replacement of human care by health technology may be unrealistic.

7.2 Caregivers' views on health technologies in comparison with those of older people

In the course of talking to caregivers, they articulated their subjective views on emerging health technologies on several occasions. Even though they have a good sense of the thoughts and attitudes of the older people they live with and could put themselves in older people's shoes, their attitudes are still quite different from those of the older people. For example, caregivers have more expectations of older people's use of health technologies, despite older people's occasional resistance to their suggestions; caregivers do not agree with the possible ageism and stigmatising associations of health technologies; they have more profound considerations of data and privacy; and they have some unique views about the caregiving responsibility that might be shifted by health and assistive technologies.

Caregivers' expectations of older people's use of health technologies

Many caregivers expressed their expectations for older adults to follow their choices of health technologies. Being relatively young and healthy, most caregivers said that they did not use health technologies for health purposes themselves, but generally endorsed the benefits of these technologies for monitoring and promoting older people's health. Therefore, they sometimes did not understand older people's refusal to use health technologies and suggested possible ways to ameliorate this situation.

“I use the smartwatch for fun, not so much for my health. I think it’s more beneficial for older people’s health, but my grandpa never listened to my suggestions unless I insisted on buying it for him.”

“Home health devices are great for ensuring the survival rate of older people with emergencies and severe diseases, so from my point of view I would hope more people to use them. Older people may be concerned about the price, so the technology companies should think more about cutting down the cost.”

Some caregivers understood older people’s resistance to health technologies, but still demonstrated soft expectations for older people’s access to these technologies, indicating that older people have the right to be informed about how health technologies evolve and the power to make their own choices about when to apply the technology (rather than whether to use it or not).

“It would be better for hospitals to set aside some offline places exclusively for older people, depending on the age ratio of patients. It’s also necessary to improve the online service at the same time, because older people using online services may still be a future trend.”

“I think people could be encouraged to try things. It would be things like offering them the opportunity to know things like the diabetes monitor and showing them how it works. It’s okay for older people not to use them right now but they should have the right to know the benefits, know that there’s somebody that they can contact if they get stuck and then make a choice.”

It is noticeable from these expectations of young caregivers that many of them believed that the application of technology is an evitable part of the

development of society and that it is imperative for them to conform to this zeitgeist and social trend. That is why they highlighted the benefits of health technology and expected the adoption of older people, even if they could identify cases where health technology is not suitable for older people. This is inconsistent with the ideas of the older people interviewed.

Rebuttals to technology-related ageism and stigmatisation

Older people referred to technology-related ageism and stigmatisation at various points in interviews, including the text size on the mobile health apps and Fitbit instructions being too small to read, and the implicit stigmatising connotations of the health monitoring devices and paper certificates of the Health Code, which led to older people's negative attitudes towards health technologies. However, caregivers countered these perceptions of older people, arguing that health technology is not categorising different age groups and excluding older people, but rather making "new laws", albeit new laws are not necessarily fair.

> *"I don't think health technologies have the problem of ageism. Everyone has different habits of using technology and in the early stages of technology development, they can only make products suitable for the majority of people."*
>
> *"Online registration is just changing the laws of on-site queueing. It's designed to be convenient for all people, although there could be issues of fairness... Paper certificate is also a convenient option for older people, and we won't look at people using paper certificates differently. The paper certificate is not as advanced as the digital code, but since it meets the needs of some people, there is nothing wrong with it."*

Nevertheless, it is obvious from the wording in the quotes that caregivers still considered digital/paper code and online/on-site registration to not be equal options and automatically assigned a “superior” status to the people who use technology. They acknowledged that the pattern of new technologies replacing old approaches and the gap between different age groups will continue to exist. If they were going to experience implicit discrimination in the future, they believed that there needs to be more humanistic care in this regard.

> *“Our generation will lag behind the new generation in the future as well. There might be a sense of being discriminated against when our habits need to be changed according to the general trend of society. So we have to allow older people to fall behind and give more care to those who cannot use technology.”*

Most caregivers were below 50. In the interviews, they tried to put themselves in the position of older people by imagining themselves as older people, otherwise, they were unaware of, and could not comprehend the inequalities that older people may suffer from accepting technologies, even though they were a group with long-term close relationships with older people. We can infer from this that in a world where the adoption of technology is a dominant idea generally accepted by young people, older people may lack the avenues to have their voices heard and to create a focus on the ageism and stigmatisation that they feel about health technology.

Profound considerations about data and privacy

Caregivers had more diverse and deeper considerations about the privacy issues associated with health technology than older people. Correspondingly

with back-end data privacy, caregivers referred to “physical privacy” as “front-end privacy” and argued that older people’s concern for it did not necessarily fall into the realm of privacy, but in the context of undermining the traditional views they held – a concern for physical privacy stems from “stubborn” adherence to the traditional views and Chinese older people’s unconcern in data privacy may also be related to the traditional views.

> *“Older people feel that home is a private place and do not want to digitally record anything at home. This may not be out of the notion of privacy, but out of the traditional distinction between the home and the external environment, just like an adherence to the traditional idea that ‘do not talk during a meal’.”*
>
> *“Older people never talked about the privacy issues associated with the technology. I don’t even think they have a concept of privacy at all. When I was a kid, my grandparents never knocked on my door before entering my room and always read my diary without my permission. Older people assume that children have no privacy.”*

It emerges from this quote that older people’s perceptions of privacy may be correlated with elder power. Caregivers believed that in the Chinese context, older people tended to apply privacy-related power to their children and family members and weakened their self-image as independent data owners; but in the UK context, older people’s considerations of data privacy were about having control and autonomy over their physical data and protecting it from infringement (though British older people also mentioned parental control in interviews). Caregivers further commented on the privacy issue of the Health Code in amplifying and abusing power, suggesting that whilst older people were

not concerned about it, this does not mean that the breach of data privacy is sensible.

> *"The fact that any security guard at a shopping mall can ask people to show their Health Code and deny access is a sign of aggression and abuse of power. I think there should be a stricter delimitation of which departments have the right to see people's health data and the public should be informed how the data is stored and protected. Older people may not be as critical of power structures as young people as they find all these reasonable and acceptable."*

Caregivers' concerns and worries led to suggestions of strengthening older people's awareness of data privacy, not just by being aware of intuitive and visible privacy breaches (such as ongoing health monitoring and filming), but also by having a comprehensive understanding of how the data will be uploaded, viewed by others and used for secondary purposes and by being alert to the possible use of health data for fraud. Caregivers also recognised that equipping older people with the awareness of information security and data privacy can be a long-term and challenging process and that there is a need to make a balance, in case older people are over-resistant to health technology for fear of privacy disclosure.

> *"Older people need to be more conscious of data privacy, but there is no need to overemphasise this issue, otherwise they can become fearful of or even paranoid about technology."*

Caregivers then threw the responsibility for protecting data privacy to different sectors, pointing out that while older people and caregivers as active users

protect their data privacy, technology companies should maintain the system and government departments should introduce laws and regulations to protect the user and clarify the responsibility, so that the data sharing could be beneficial to the public.

Responsibilities and ethical issues in health technologies for ageing in place

Older people's views on health technologies for ageing in place centred on their stigmatising connotations and comparisons with human carers, but caregivers talked more about responsibilities – who should be responsible for older people's lives, the extent to which health technologies can take over the responsibilities, and the ethical issues that are associated with technology-assisted ageing.

Firstly, caregivers believed that caring for older people should be relevant to all members of the public. In China, supporting older people is publicly perceived as children's obligation. Even if an older person was sent to a care home or a professional caregiver was employed at home, their children are still not exempted from the responsibility of caring for their parents, and health technologies similarly cannot free children from the responsibility. In the UK, caring for older people is gradually transforming into personal and social responsibility, and caregivers expect older people to be responsible for their own health, as well as having better social systems to support older people's health and ageing in place.

> *"In China, if it is not the children who take care of older people, both the older people and the children will be sat in judgment. Even if the children are busy at work and acquired health technologies for their*

parents, they will just be slightly relieved but cannot completely take off the caring responsibility."

"I suppose older people here can always be more calm and mindful of their health...if the health system in the UK is better and older people can get faster and more accurate diagnoses, our caring for them will be easier!"

Secondly, caregivers widely agreed that using health technologies for ageing in place is still a developing concept and that full utilisation of these technologies requires a vast range of external conditions, including the acceptance of the concept by older people and the public, whether older people are physically able to manage the technology, whether the after-sales service is available, and whether the technology can be embedded with a certain degree of humanistic care.

"It's not yet a good time to popularise health technologies as older people still have the traditional concept of living with families... The voice features of these technologies need to be refined to provide more emotional care for older people."

"Using health technologies for ageing in place is not reliable enough. Technologies need to be maintained by people and health data needs to be analysed by people."

The ethical aspects of technologies for ageing in place were also a big concern for caregivers. They mentioned the possible violation of older people's autonomy over self-management of health, the extent to which they could give permission for data access, how to ascertain responsibility in the event of

omissions and false alarms and the unequal distribution of resources due to the differences in the economic status of older people.

> *"Even the most delicate instrument can make mistakes. If an urgent health problem is missed, who should be accountable for it?"*
> *"Currently the health equipment is only available to those affordable, which could amplify disparities in the care for older people."*

These considerations of responsibility and ethics by caregivers are matched with their caring roles. For family members, more perceived responsibility for older people leads to more disapproval of technology as a complete substitute for caregiving, as the binding responsibility (not counted by time and costs) ostensibly reduces the need to use technology for ageing in place, especially in China. For professional caregivers, there is both support and concern about technology-assisted caregiving. Interestingly, they are not worried about losing their jobs (which is a topic mentioned by some older people), because they are still confident in their abilities that are superior to health technology, such as greater autonomy and humanistic care.

7.3 The role of caregivers in older people's use of health technologies

Most caregivers said they assumed an important role in older adults' acceptance and interactions with health technologies, including acting as introducers to initiate the purchase of health devices for older people, as trainers to teach older adults how to use health technologies, as guardians to represent or replace older people's user identities, as technology reclaimers to deal with a range of issues that arise after older people reject the technology, and as coordinators to layout the environment in which the health technology is

located and to supplement the parts of the process of using the technology that has to be done manually. The first two roles are similar to those found in older people's statements, as they also mentioned the situations where family members purchased and gave away health devices and the scenarios where they were helped by caregivers to use the Health Code and the smartwatch. However, the latter three roles appear to be barely realised by older people. The details of these five roles and how they are developed are described below.

Caregivers as introducers

In the phase of introducing technology into the family, caregivers see themselves as taking on an important responsibility. Particularly for the latest health technologies, as older people could be slow to know them, caregivers (often the children of the older people) are not only the ones who guide older people to receive the information and knowledge of technology but also the actual purchasers of technology products. In the case of health technologies that have been widely recognised, there were instances where older people actively proposed the need to purchase and use them, while caregivers would act as intermediaries for the purchase.

> *"I bought an oximeter for myself last year because of the COVID-19 pandemic, and then I felt it also necessary for my parents and bought another for them. They were really appreciative."*
> *"My father-in-law was a doctor. He was the one who asked me to purchase the blood pressure monitor as he knew there were several older people with high blood pressure in our family."*

Caregivers also mentioned that sometimes purchasing and guiding was not an independent act dominated by them, as older people can interfere in it or put

forward new demands after accepting the products, which makes them a bit embarrassed. That is, even though older people need caregivers to be introducers and help with purchases, they still want to have some control over "their" technology, rather than being passive users who are wholly represented by caregivers. In other words, caregivers' role as introducers is sometimes a combination of their subjective purchasing behaviour and older people's feedback. This also corresponds with older people's statement of "I bought it myself", as they may virtually play a decision-making role in the adoption.

> *"I've just bought my dad a new smartwatch. I bought a relatively cheap one as he had wished, but after using it he found it did not work well. I think it would have been better to buy an expensive one at the beginning, but then he would have blamed me for wasting money."*

Caregivers as trainers

Caregivers' role as trainers reflects an inversion in the role of "mentor" that is traditionally anchored to age and experience (Carlo and Bonifacio, 2020). Three distinct types of feedback emerged in the development of this role.

Some caregivers were skilled and comfortable with the training process and even summarised effective techniques, such as using visual presentations and repeating complex steps, and they received affirmation that the older people were satisfied with the instruction.

> *"I helped them install the health apps on their phones and taught them how to use them as well. One tip to teach them is to see them as if they do not know anything about technology, so I wrote very detailed*

steps and drew illustrations, and envisioned a lot of problems that they might encounter and told them how to fix the problems."

Some caregivers found it difficult to teach older adults to use health technologies because they were unable to instil the logic of technology into older adults and older adults could not operate independently after repeated instructions. Caregivers were sometimes troubled and felt annoyed by this, while older people in turn accused caregivers of being impatient and got frustrated with the use of technology.

"I've taught my grandma before to use an app to order prescriptions, which only takes three steps, but she just can't learn. I don't know if it was because she did not want to learn, or because she could not understand what I told her. She just gave me her phone and asked me to do it, sometimes even complained that I shouldn't have bought her the smartphone."

"I would do it step by step with them and hope they will do that themselves in the future. But it's having to repeat a lot of time. I'm always showing them more than once. It can be five, six, seven, eight times, and sometimes they still don't get it."

It was also pointed out by caregivers that the older adults did not actively ask for help, so it was difficult for them to observe which aspects of training older people needed.

"I think some of them don't have the confidence to ask for help. If I don't know that they need the help, I'm not gonna know that they

haven't set it out, cause it's not something I'm always keeping an eye on."

However, in conjunction with older people's interviews, it can be found that not asking for help may not be due to a lack of confidence but may instead be an attempt to build confidence by becoming independent technology users. When caregivers assign themselves the responsibility of teaching older people, older people are simultaneously challenging this inversion of mentorship.

But caregivers admitted that after all, they are not professional technicians and that some technical issues could not be solved on their own, so they would try to understand how older people think of technology and further criticise the complexity of technology design.

"I myself am not a digital champion and there were some things that I wouldn't understand. So I'm learning as well."
"Once my grandma's exercise data suddenly stopped showing up on the lock screen. I tried to fix it for them but failed. If the technical logic is complicated even for young people, it is understandable that older people are not able to learn it."

Caregivers also identified the existence of alternatives to technology as a reason for the difficulty of teaching. From the perspective of older people, the coexistence of technology and its alternatives does not provide them with more choices but rather gives them a reason not to learn about the use of new technologies (caregivers used the word "excuse" instead of "reason", demonstrating a sense of frustration).

"In fact, older people are not completely unteachable. They learned the Health Code very quickly because they can't go anywhere without it and they must learn it no matter how hard it is. But they can still go to the hospital for on-site registration and ordering prescriptions, which becomes an excuse for them not to use the app, so the app is just dispensable for them."

In describing their experience, caregivers questioned whether they should be the ones to take responsibility for teaching older people. The one who designed detailed illustrations, for example, reflected on why the health apps did not come with their own instructions; caregivers who had encountered insurmountable problems also indicated that they would prefer to have a team of professionals develop a curriculum suitable for older people than to invest more effort in teaching technology.

"I think there needs to be more support in place for older people to get online or get along with health technologies. If there was a regular thing for the older generation that they attend, such as a session once a week, we're going to get this done. The sessions should be one-to-one, rather than just read the leaflet to them."

Caregivers as guardians

Caregivers as guardians are commonly found in the use of health apps, especially those for making medical appointments and ordering prescriptions, referring to situations where caregivers are required to register and represent older people's identities with their personal information (e.g., name, phone number, address, etc.) because older people themselves are not able to use these apps. Caregivers found that in many cases representing identities is more

convenient for them and for older people than having older people use the apps on their own, and they endorsed their obligation and responsibility to undertake this role.

> *"I always help my grandparents get medicine online. Although they have their own smartphones, it bothers them too much to register, fill out personal information and make the payment on the app. I would rather use my account to do it for them."*
> *"My mother-in-law uses a feature phone. When she has to go to the hospital, I will use my phone to make an appointment for her. I think this is what children should do for parents."*

In some cases, multiple names can be added to one account as the actual persons to obtain medication or treatment; however, some apps only allow one account to link one name, which creates some problems for caregivers acting as guardians. For example, when an appointment is booked for an older person under the name of his/her caregiver, the caregiver must accompany the older person and show identification during the visit, which in turn creates more trouble. In addition, discrepancies between online registration and the actual person attending and receiving treatment can also cause difficulties in data management for hospitals.

Some caregivers were concerned about how older people living alone should use health apps to make appointments. Apart from learning entirely on their own, caregivers believed that hospitals should provide more convenience for them, and even came up with innovative ideas on how these dilemmas would be solved in the future.

"Most of the older people I met were still using feature phones and could not use the Internet and install health apps on the phone. If they came to the hospital by themselves, it would be impossible to force them to use the apps to register and make the payment for medical treatment. The hospital should provide more services then, such as having more staff to offer help and making the assistance more visible."
"I think a better way to facilitate older people is to have family doctors without going through an intermediary platform. Unfortunately, there is still a lack of medical resources."

Caregivers who perform as trainers and guardians both mentioned the lack of clarity in the attribution of responsibility. Although they seem to act naturally in the relationship between older people and health technology, it is essentially driven by morality rather than bound by any laws or official regulations. This is contrasted with a possible lack of responsibility on the part of other actors, including technical support teams and digital service facilitators in hospitals.

Caregivers as technology reclaimers

Selwyn (2004) observed that there was recycling and informal redistribution of ICTs in the family and that older people were often "at the end of such recycling chains", gaining access to old technologies that were no longer used by their children or other family members. This phenomenon is confirmed in interviews with older people ("*My mobile phone was redistributed to me by my daughter",* p.119*)*. In the interviews with caregivers, however, an opposite situation is found. This is because new policies aim to facilitate technology for older people, or sometimes children regard older people as the "first beneficiaries" of technology but older people are reluctant to adopt. After older people receive devices, they either simply discard them, or just give them a try and then for

some reason stop using them, leaving the still-new technologies to flow back to caregivers or other family members.

> *"The blood pressure monitor I bought for my father was returned to me because he said it didn't measure accurately. I don't need to measure my blood pressure regularly, so it sits unused at home now."*
> *"Once the government distributed smart bracelets to older people living in the care home, but older people were not really keen to use them. They either didn't know how to use them or didn't think they needed them, as they were always staying in the care home without going out. In the end, all these smart bracelets were re-stacked in my office, and I had no idea how to deal with them."*

We then discussed the reasons for this situation, and caregivers suggested that there might have been a lack of prior research on older people. For example, children did not have a good understanding of older people's requirements and the effectiveness of the products when purchasing them; and the people who made the decision to distribute the technologies did not have a site visit to investigate older people's living conditions and their perceptions of the health technology. When the technologies were delivered, they did not anticipate the outcome of "refusal" and did not make proper follow-up arrangements, resulting in a waste of resources.

> *"The government's idea of acquiring health technology for older people was good at first, but every person in our care home has different personalities and mindsets, and it may be necessary to do some research ahead to know what they think of the technology before these resources could be reserved for those who really need them."*

Caregivers as coordinators

Caregivers' role as coordinators may be more implicit, or even a role that the caregivers themselves were not aware of. First, caregivers naturally underwrote the job of setting up the environment in which technology would be implanted. In a physical sense, this means conducting preliminary environmental research to make sure the appropriation of the new technology into residential places is possible; for care homes, it also includes communicating and negotiating with the government or funders and applying for funding for the health technology. In a broader sense, the role encompasses normalising the presence of health technology by rendering older people psychologically more receptive to or familiar with new technologies and by empowering the family to be better off. Greenhalgh, et al. (2013) referred to this role as "bricoleur", as "successful technology arrangements were often characterised by bricolage", in which the bricoleur role appeared to develop a detailed understanding of older participants' needs and match them to the technology. The discarding of resources mentioned in the previous section can occur when there is no one in the role of bricoleur or the role does not work properly.

> *"Installing health monitors in the care home would certainly be a boon to older people. As a staff member, I would first consider whether the technology is effective or not, whether the price is reasonable, and whether I can apply for funding."*
>
> *"I know that the healthcare technology can do more, but we just don't have some facility here. For example, some functions can only work with WIFI, and we need to decide whether we are going to have it."*

"Many advanced technologies are beyond the reach of the average family. If we don't earn much, our parents cannot accept spending too much on these technologies."

Second, caregivers also took on the job of complementing the missing links in using health technologies. For example, when there is a health alert, caregivers need to perform further examination or send the older people to the doctor; when programmed technologies execute scheduled mechanical sessions, older people who prefer emotional care would ask for more psychological support from caregivers; caregivers also provide occasional checks on the safety and usability of the devices, including recharging, repairing, or replacing them.

"Older people could push the button on the device if there were some sort of emergency for them. If someone was to have a fall, that would automatically notify me. I would arrive immediately for help."

"A lot of older people in the care home are resistant to health technology, finding it cold and impersonal. We always talk to them more and give them more emotional care."

Caregivers' role as coordinators echoes older people's view that technology needs to be cared for. It forms a structure as illustrated in the figure below. When caregivers and health technology take care of older people, health technology also need care from both older people and caregivers.

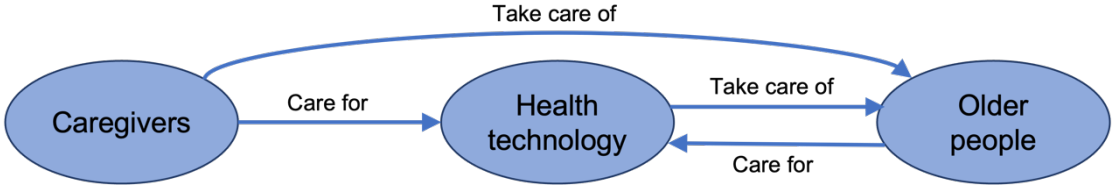

Figure 7: The caregiving relationship

This caregiving relationship underlines the fact that diverse types of artificial support are required at all stages of older people's interaction with health technology. Whilst health technology is designed to create more independent lives for older people with fewer coordinators, this independence is often incomplete and conditional.

7.4 The role of caregivers in older people's participation in the development of health technology

I also had conversations about older people's participation in the development of health technologies with caregivers. Caregivers generally acknowledged the necessity and advantages of engaging older adults in the development of health technologies but identified major shortcomings in the current situations of participation. In response they suggested, based on their own experiences of interacting with older people, the potential role of catalysts they could play in older people's participation and the circumstances needed for this role to materialise. These roles include representatives of older people's identities in participation, organisers of participation activities, and mediators in promoting older people's participation.

Caregivers as representatives

Caregivers' most direct role in older people's participation is to represent their identities and voices, particularly for those who are too vulnerable to participate, have declining capacities, or have difficulty expressing themselves. Caregivers believed that with a great deal of daily contact with older adults, they are the ones who know best about what older people think and having them represent older adults in participation both compensates for the lack of discourse from the

frailest group and makes it easier to communicate because of their greater experience with technology than older people.

> *"It is necessary for older people to participate in the development of health technologies. For older people who cannot express themselves in public, a more appropriate way to involve them is to invite representatives of the community, older people's children or caregivers to represent their voices."*
> *"It's necessary to get everyone's opinion, even the vulnerable ones. Their caregivers or their children can represent their user identity and speak for them."*

However, there may also be a range of ethical issues with caregivers representing older people in participation and it seems that caregivers have not been aware of these issues. A paper published by the University of Sheffield (2015) on the guidance of ethics in research involving older people emphasised that research seeking to access the views of older people by asking carers or surrogates is "bad science and unethical". This may be because, firstly, the lack of informed consent and respect for older people as autonomous individuals in this process could result in a threat of paternalism (Seedsman, 2019). As the peer-to-peer agreement becomes a three-way communication, it needs to be considered whether and how such representatives should be authorised, whether the represented older people are able to express possible objections if they are on the spot, and how we know the elaboration of the representatives (caregivers) is in line with what older people's real thoughts if they are not present. Secondly, caregivers' representation of older people's identities does not mean that they could put themselves entirely in the position of older people. In the course of participation, the representatives are likely to speak on behalf

of older people while also intermingling their personal comments, therefore degrading the effectiveness of “older people’s participation”.

Caregivers as organisers

Enthusiastic caregivers raised their possibilities of acting as organisers for participation activities, as they have good contact with older people, who are more likely to trust activities initiated by them and more willing to speak up and tell the truth. These “advantages” are often not enjoyed by pure technology workers. The inhibitions of interacting with strangers in a formal setting (rather than in everyday life) may also be the reason why some older people said in interviews that they “do not know what to say” in technological participation.

> *“It may be difficult for technology companies to initiate interactions directly with older adults. Caregivers could be co-initiators of technology participation.”*
>
> *“Older people prefer to talk to someone they know, and it is better to go through the community or a family member to step in and ask older people to join in a small meeting room together. It is important to guide well in getting feedback.”*

Caregivers also suggested incentives that can attract older people to participate and approaches to make it more effective. The validity of these approaches was confirmed by the practice of “coffee morning” as a “gentle methodology” to involve older people in the EIDS project. The gentle methodology aims to establish a temporary structured space to share daily life activities (such as eating or building something) with participants, so as to emphasise the natural and gentle contact with older people (Pottinger, 2021).

"It is best to have one person in charge of all the technology tests and surveys in an area, with the person in charge slowly getting to know the older people as their friend or offspring and offering household essentials, such as eggs and tissues, as rewards for participation."

"Older people are less likely to answer telephone surveys. I think it's better to have carers get older people together for group discussions and prepare some fruits and snacks for them, then they will be willing to tell the truth in a chatty way. The group discussion will also be a good way to get the percentage of people who agree with a certain idea."

However, these incentives may also generate controversies. For example, unequal recruitment, as one of the concerns of older people, could be reinforced by this relational networking; too much reward and sharing could be a threat to participants' motivation and authentic feedback; and there would be possible under-representation of participants (e.g., older women may be more interested in household goods as reward and group socialising, according to the observations of caregivers).

Caregivers as mediators

Recognition of the importance of older people's participation in health technology is much higher among caregivers than among older people themselves, and that is why it derives caregivers' role as mediators – caregivers hope that they can make older people and technology companies recognise that older people's participation in the development of technology is necessary and important. Caregivers who had these ideas raised further expectations for older people to have more proactive agencies being technology users but were

relatively reserved in their representation of older people's identities in participation.

> *"If technology companies are developing health technologies 'for' older people, older people definitely need to be involved in the research and development process. It would also be preferable for older people to initiate their needs to the researchers and developers."*
> *"Older people's ideas should be incorporated into the design of health technologies. They are important users with a responsibility to express their views... Ideally, participants should have a big-picture outlook and be able to consider older people as a group in terms of shared concerns and possible ways to improve technology."*

For people working in technology companies, especially those recruiting older participants, caregivers also gave their own perspectives on expectations and considerations for involving older people.

> *"The idea of engaging older people in health technology is brilliant. Technology developers may consider older people have not really had much to do with digital technology, but older people can also take centre stage to shape the technology that is relevant to them. Developers need to recognise this."*
> *"Young people could be recruited quickly through online platforms, but greater investment is required to involve older people. If the technology company only intends to make a profit from the product, it will be uneconomical to involve older people; but from my perspective, older people's participation is still necessary, and the government should do well to support this."*

It is notable that caregivers' role as mediators tends to be more attitudinal rather than making practical suggestions, because they may not necessarily feed back these requests directly to older people, technology workers or the government. Hence, caregivers as mediators are actually forming imaginaries of older people's participation in the development of technology, instead of acting as "promotors" to commit to older people's participation.

Pessimism about older people's participation in health technologies

A very small number of caregivers did not agree with the necessity for older adults to use health technologies, nor did they have a favourable prospect of their participation.

> *"I think it might be possible to engage a limited number of target users to have a short-term trial of the technology, but there is no need to embark on a large scale of mandatory participation. It's also difficult for older adults to give quality feedback if they did not psychologically accept the technology."*

This is indeed encountered in the trial of the Fitbit by older people in the UK. Some older people gave up using the Fitbit at the beginning because of frustration and were therefore unable to assess the usability, accuracy and ethical issues of the technology. Although the frustration may still be valuable to the technology developers, older people were reluctant to recall the experience and confess to the difficulties.

In addition, stakeholders share the consensus that the purpose of participation is for better coordination between people and technology, but if technological

participation goes against older people's willingness, formalised and task-oriented involvement can be counterproductive, and there may even be situations where false data are created with pointless interactions.

Chapter 8: Findings and analysis – Technology workers

The third group of interviewees were ten people working in the health technology sectors from the UK or China, and some with experience working in both China and the UK (and possibly other countries). They will be referred to as “technology workers” in the following text. This group of interviewees were relatively young, all under 45, with work experience in health technology ranging from three to fifteen years. The companies (or research institutes) they worked for were varied and they were in different positions, including developers for health apps, researchers for electronic health records, project and brand managers for health technology companies, user experience (UX) designers for ageing-in-place health technologies and an innovator of health assistive technology. They introduced their work and the health technology products they worked with and expressed their views on the use and participation of older adults in these technologies. It was found that technology workers shared similar systemic logic about emerging health technologies, deriving from their “technology-centred” career goals and social identities, which differed significantly from those of older people and caregivers. I will also not separate the findings of the ten technology workers by their countries due to relatively strong consistency in their views.

8.1 Technology workers’ reflections on their work

The interviewees were first asked about the basics of their jobs – getting them to recall their initial motivation for the job and describe the health technology products involved in their work and daily routines. This section is also organised in this way.

Work motivation

Interestingly, almost all the technology workers interviewed acknowledged that their current job was not entirely out of their own choice and that their field of study before had little to do with healthcare. Some people joined the company or institute by chance; and some others thought that they entered the industry simply because the job offer was the best fit at that time (combining factors such as salary, location and corporate environment). Due to a possible lack of interest in health technology, they confessed during the conversations that in their daily work, they had seldom reflected on topics covered in the interviews (in later sections).

> *"I didn't know there was such an industry at the time. The company was working on a German clinical information system, and I was able to help with the translation by knowing German."*
> *"I was looking for a start-up and hoped to experience the culture of designing new products quickly, not picking this company specifically for doing healthcare."*

The more positive technology workers recognised the value of their work, believing that the development of health technology is important to human society, and it is great to be a part of it. But their involvement in the industry was likewise driven by external factors, such as funds, interaction of relevant disciplines, public interest and demand.

> *"So basically, I started undergrad as an engineering major, but I did not like it. And so, to make things more interesting, I decided to double major in cognitive science. What attracted me after double majoring was human-computer interaction. That was the sort of overlap*

between the two disciplines... After graduation, I started to work here, doing design work to improve user experiences in robots and other healthcare technologies."

"I was working in a creative industry and joined a hackathon eight years ago. They wanted something that used artificial intelligence systems for social care. I think it has a positive impact on people's quality of life. So I thought, let me see if the system that I created can actually transit funds. I tried it, and it works."

The innovator noted that as the hackathon received the attention of big media platforms, she got a flood of emails from the public, asking if the product was available. She then realised that there was a demand for it, which drove her to further work on it and ultimately brought the product to market.

Development processes for health technologies

The health technologies involved in the interviewees' work not only covered most of those mentioned by older adults (e.g., health apps, wearable devices, ageing-in-place technology, etc.) but also included cutting-edge technologies that were still under research and development, such as advanced healthcare robots. The interviewees described the development processes and the current status of their products. The products that are successfully circulating in the marketplace have gone through several stages from research to application, and the functional workers of a company are often responsible for only one of these stages (which will be detailed in the next section). The founders and managers of technology companies explained the steps in more detail, including feasibility tests, licensing, continuous improvement of hardware, software and related configurations, and ongoing promotion and updating of the products.

"Our company builds standalone health apps to digitalise the traditional GP process, which is called telemedicine and online prescriptions; and also mandates a certain functionality we have created into apps developed by other companies... It is usually six to twelve months from the development of a technology to the launch of it."

"It took about three years to confirm what features we need to have in the system and improve the hardware. And then another two years to establish a business and do all of the paperwork like funding and employees. So all in all, I'd say it was five years from the beginning of the idea to the market... Now we are updating the app every week and having more partnerships in different countries."

There were a few technological products that had not been accepted by the public upon their release into the market, probably because of expensiveness or complexity. With few users, the relative maintenance cost of the technology rises, and profit-driven companies may therefore forego further development and support of the technology.

"The smart walker[22] *cost 12000 pounds if you're gonna buy it for yourself. They had a few in care homes that still were being used but there's no technical support for it."*

Health technologies that are not yet available may take longer to develop, require more financial support or need to be facilitated by the broad political

[22] Smart walker is a balancing tool designed for people with mobility difficulties, featuring a large collection of sensors and a screen to provide users with health data and medication reminders. The website of the product is not provided here to protect the interviewee's occupational information.

and economic environment; some people pessimistically felt that some of these technologies would never be implemented in the future because there are too many obstacles to break through.

> *"Our company started to develop an Internet healthcare platform a few years ago. At that time, the company was in transformation and the leaders wanted to try everything, but in the end, not many of them were put into use. In China's social environment, the market would not give companies so much time for trial and error."*
>
> *"The application of electronic health records is an arduous task. Firstly, when training the model, we need to require health data from the hospital, where personal privacy is considered. I've talked to people in the hospitals and found that some people don't quite trust and understand AI as a tool or have ambivalence about machines trying to replace them. A lot of medical scrutiny needs to be done for these tools, with a long time and delicate negotiations."*

However, there were also researchers arguing that their goal was not to bring the technology to the market to be adopted by people, but rather to create different prototypes for testing, to find out the capabilities that will be more desirable to future users through experimentation and to establish research priorities.

> *"None of the robots that we work on are going to become products on a shelf. They are just for research and constant development. We are reaching target users to know which capabilities we should focus on."*

The responses from technology professionals demonstrate that the process of technology development and acceptance is highly complex, which brings together not only diverse functions across the company but also inputs and influences from outside the company and even outside the health technology sector. Some of these are visible steps, referring mainly to the interaction between technology workers and technology, as well as between technology workers; but there are also plenty of sections that are easy to overlook and hard to visualise, such as time and cost, legal and ethical issues, possible technological competitions, etc. The following two paragraphs will move to specific aspects of the process and reflect on the values and challenges involved, from the perspectives of being an individual and being part of a team.

Job description

As individuals, technology workers described the day-to-day routine of their work and their roles in making the health technologies in the companies or institutes. In the process of adapting to the industry and accumulating experience, they tended to establish a "comfort zone", meaning that they would like to stay in a specialised area of expertise without a sense of risk (White, 2009), but they also complained about the repetitive and monotonous nature of their work.

> *"I write code every working day. The current software function to be implemented is storing user data, sort of a backend support system that will be used for several apps of the company."*
>
> *"My job is doing brand management for the health technology group, and it includes writing news reports, producing videos and posters and planning how to promote our products... I feel like I'm actually doing*

similar work day in and day out, boring and mechanical, to my comfort zone. I would like to stop, or even, retire now."

Those who tried to move out of their "comfort zone" shared the challenges they (had) faced. For example, for those who spent considerable time on technical design, their "comfort zone" was to create prototypes of technology with subjective logic and therefore they were completely familiar with how to operate the technology step by step. Their main challenge, however, was to "show others how to use it" and to incorporate different people's logic into the technology as it was to be updated.

"The tech stage was my area... sometimes you think things work right, but then you take it to someone, and they don't use it the way you think or you design it to work. So that was the most challenging. And recovering from that, I'm trying to implement their feedback into the next design, and that was eleven cycles until I had people use it the way it's intended."

But whether they chose to stay in their comfort zone or not, most technology people mentioned that their work was very "task-oriented". They did not have much agency but had to follow orders and instructions from clients, group leaders, and policies.

"Each of our projects is in the charge of one manager, who is responsible for refining the user requirements, and as a back-end programmer, I'm just going to write the code to fulfil those requirements. We don't need to worry about whether users like the interface of the app or not, and whether it's easy to operate."

"Who will be our target users depends on what the company's leaders think. There are a lot of things that I can't do right now in my position because I don't have enough power to speak."

"Industrial design is kind of the design of physical products. So, clients will come up with an idea, and you design mock-ups for them. And then you send it off to the manufacturers, and you have to show them how you're gonna make it. You have to know about plastics, moulding and things like that, what components are going to be in it. And they get back and forth redesigning it with the factory until it's ready to be made, and then you get samples made."

When asked what the next step would be after the samples were made, the respondent said she was not sure:

"I don't know to be honest... maybe look at longer studies and see whether I can collaborate with other colleagues and collect health data... I'm not sure."

By comparison, the role of innovators and company leaders is relatively free, but they also reported a wealth of unanticipated, out-of-control, or must-do work, which can disrupt the process of technology development or go against the original intention of the technology design. For example, when the marketability of the technology was unsatisfactory, the sponsors withdrew their investment, or the objectives of the technology did not match the new policy, the technology workers would be obliged to launch repetitive experiments, conduct meetings and consultations, write new documents and reports and recycle the previous steps. Surprisingly, they calmly accepted these trivial burdens around technology rather than characterised them as "frustrations". In light of their work

motivation, this may not be a result of tolerance of difficulties with passion for work, but rather of passive understanding and admission. As one person put it:

> *"I didn't know I was an innovator. I was just putting all the 'approvals' together. And I never know whether the technology would actually work, but I know I cannot expect success."*

Work team

All technology staff interviewed collaborated with the team and many of them emphasised the importance of teamwork. Their teams can be as small as two or three people, or as large as ten or more. The common denominator of the teams is that the members are relatively young and have diversified disciplinary backgrounds.

> *"The company is full of young people... We have team members who studied chemistry and biology and specialised in business English and other languages. There are maybe more people from medical and pharmacy backgrounds in the technical departments."*
>
> *"It was a team of seven or eight people. There were three experts on the team. One was an industrial designer, and one was more of a scholar in human-robot interaction. They had more of a technical background in engineering. Then we had a UX designer. So those were three different disciplines, sort of like spearheading the team. The rest were research assistants."*

Respondents felt that youthful teams are dynamic and creative, working at a fast pace. Technology workers with diverse backgrounds and expertise can collaborate in a complementary way, even when the company has branches in

different regions or countries, and when remote collaboration was required in the last few years because of the COVID-19 pandemic.

> *“I don’t come from a business background and the risk is very high to make mistakes. When I invited someone who had business expertise to be with me in the company, a lot of things got much easier.”*
> *“We are split between two different sites and obviously with the pandemic, everyone was remote. But we can easily support each other when the projects need it.”*

What these respondents rarely realised is that the youthfulness of the team may lead to a lack of knowledge about the target users in other age groups. When their health technology products are aimed exclusively at older people, it would be especially difficult for them to design the technology from the perspective of older users and to include the target users in the development of the technology (will be further analysed under the second and third subtitles of this chapter). This could create a gap and conflicting interests between developers and actual users, as “most people are unable to imagine technical options outside their own experiences” but only be able to seek potentially patronising solutions “for” older people through hypotheticals (Eisma et al., 2003).

Except this, technology workers were aware of the challenges posed by the company’s hierarchy and teamwork, especially in the context of a big company or working on large projects:

> *“Our company is strictly hierarchical. There is a manager in every small group, and above the managers, we have department heads, and above that we have the company's divisional heads, and at the*

very top we have the 'big leader'... People are often not very cooperative with us. For example, the technical team has no sense of publicity, and when we want them to provide some pictures of the products, they will think we are making trouble. Communicating across departments and through the hierarchy slows down the efficiency."

"Working in a team is not easy. Let's say in the field of computer science, software engineers and algorithm engineers are two different roles. An algorithm engineer may not be able to make his algorithm a complete tool, but others on the team may have such an expectation."

Such challenges in relationships and communication may not only act as a hindrance within the company. Still, they may also have a negative impact on the diffusion of technology, as misunderstandings could manifest in all aspects of the technology product and be further amplified as it takes shape. Similarly, if user feedback also needs to be communicated through the hierarchy, its credibility may diminish as the noise increases.

8.2 Technology workers' perceptions of older people's acceptance of health technologies

Most of the health technology produced by interviewees targeted older people, but technology workers stated that they did not have much contact with older people in their work. Technology workers considered themselves more as independent producers of health technologies and their perceptions about older people's acceptance of health technologies were often shaped by the concepts that companies assigned to their products, as well as by broader environmental and policy drivers. Naturally formed barriers to older people resulted in their subjectivity and lack of knowledge about the real lives of older people. They

also admitted that they may therefore not play as direct a role in older people's acceptance of health technologies as caregivers. The following sections provide an analysis of their perceived benefits of health technology products (especially for older people), their perceived acceptance of health technology by older people, how and why health technologies may exclude older people and possible improvements of health technologies.

Technology workers' perceived benefits of health technologies for older people

Many technology professionals believed that the primary goal of health technology was to establish users' independence for self-health management and, in the case of older people, the ability to maintain a certain level of independence despite reduced mobility and memory. Health technology is therefore like a supplement to functional deterioration to lessen older people's dependence on caregivers. Technology workers assumed that they needed and had already designed the technology to be as simple as possible to achieve older people's "independence" when using the technology.

> *"It is very easy to use our technology. We're providing a piece of technology that provides independence that people really want to still keep as they get older, so we also want people to be independent when they use it or try it or set it up."*

Secondly, technology workers emphasised how digital health technology can improve efficiency for the traditional healthcare industry, through online appointments to reduce on-site queueing, telemedicine to reduce in-person visits to hospitals, and electronic health records to speed up patient data processing. Technology workers suggested that the time savings would

translate into convenience for all and would be an even greater benefit for older people who are more in need of medical resources and more likely to suffer from emergency and severe diseases.

> *"Electronic health records and Internet healthcare platforms can effectively shorten patients' time they spend in hospitals, and hospitals can manage their patients more efficiently. Models trained with AI can even improve the accuracy and efficiency of diagnosis and generate more precise decisions for individual patients."*

In addition, technology developers thought that health apps and health monitoring devices were designed to make people "get sick less" by regulating their health data. They hope that health technology can be a "preventive" tool for users so that they can know more about their bodies in their daily lives and curb the development of diseases promptly, to minimise the risk of getting serious diseases and to further address the problem of limited access to hospitals due to the shortage of medical resources.

> *"Health apps can take users' daily diet and activities into their database and make suggestions. They are not meant to cure the patients immediately, but rather plan for the future, making them get sick less often. This could also potentially solve the 'supply-is-less-than-demand thing' because there are too many patients but fewer doctors."*

It is obvious from the above three points that there are significant differences between the benefits of health technology as envisaged by technology workers and the expectations and use of health technology by older people. For

example, although technology developers assumed that their technology was designed to be simple enough for older people to use it independently, older people and caregivers reported many situations in which help was needed; some older people did not care much about the efficiency of digital healthcare platforms, as they did not have access to them or preferred to meet face-to-face with doctors; the notion that health technologies could make people "get sick less" also fails to fulfil the expectations of some older people who wanted health technologies to "cure" diseases. These situations imply that technology workers' preconceptions about health technologies' benefits for older people do not necessarily match older people's actual needs, which creates a dilemma in older people's acceptance of health technologies.

Older people's acceptance of health technology perceived by technology workers

Indeed, technology workers were aware of older people's possible low acceptance of emerging health technologies (see p.15). They initially attributed the low acceptance to unaccustomedness and some external factors (surely older people had already reported more factors in interviews and technology workers realised others later).

> *"I think there is definitely a greater acceptance by young people than older people. Older people who haven't used digital communication tools such as WhatsApp and WeChat won't be accustomed to using digital healthcare products."*
>
> *"There is a negative acceptance from European older adults. Maybe there is a lot of influence from science fiction movies."*

Three different kinds of attitudes arose from technology workers regarding the low acceptance of health technologies among older adults: a desire for older people to accept and use health technologies; not minding whether they accept or not; and looking for alternatives to “compensate” older people’s lack of acceptance to health technologies.

Technology professionals who favoured older people’s acceptance strongly endorsed the advantages of health technologies and believed that older people’s rejection of them stemmed from a lack of understanding and habituation. They were optimistic that if older people were shown and informed of the usefulness and accessibility of health technologies, they would have a greater likelihood of acceptance. Meanwhile, their attitude was somewhat soft, saying that older people should not be forced to learn and use.

> *“I think we can try and persuade older people to accept. Some people can be persuaded when it’s like, here is the specific use and this is a low-cost technology. But you can’t force people, can you?”*

Technology professionals who did not mind whether older people accept health technologies (or were fine with older people not using health technologies) were very few, and their viewpoints were still based on an acknowledgement of technology adoption, like a compromise following the failure of soft persuasion.

> *“The decline of health and mobility are common among older people, and we can do nothing if they just cannot learn new technologies. We will have to give up on the market of older population.”*

Similarly, technology workers who sought alternatives also followed the idea of trying to include older people in the technological world. They considered a balance between persuasion and compromise and underlined the role of caregivers in establishing access for older people.

> *"There is also the case that the children of older people are accustomed to using the health apps. They can sign up for their parents and log in with their parents' accounts via their mobile phones. What we are trying to do is to functionally allow caregivers to apply for healthcare services on behalf of the older people."*
> *"We've introduced fall detectors and sleep sensors in the retirement villages. The older people don't actually have to do anything with those. They are just there and operated by us and their caregivers."*

Technology workers who thought of these alternatives had preconceived that "older people have children/caregivers", which was not always the case. The older participants of my research already consisted of many who lived alone for a variety of reasons and were unlikely (or unwilling) to be helped and represented by caregivers. Moreover, the alternatives that technology workers tried to establish contradicted the notion of "independence" that health technologies aimed to achieve. Technology workers also recognised that the representation of identities sometimes required more scrutiny and they needed to do more work to that end, inspecting ethical issues and technical vulnerabilities in it.

In addition, technology workers were aware that the adoption of health technologies is not an autonomous choice in some cases, regardless of whether older people actively accept them or not. Besides the Health Code that

was mandatory in China during the pandemic, emerging technologies such as electronic health records and digital health platforms may create similar situations in the future.

> *"Patients may listen to doctors' recommendations of technologies, or when the digital healthcare tools become mature technology, they may naturally integrate into the hospital's management, and it is no longer a personal choice."*

On a deeper level, what technology workers referred to here was an issue of power. In the process of moving towards a digital society, not only the users are a "social element" that is wrapped in the trend of using the technology, but the technology workers are also a part of the power relationship, sometimes appearing to be passive creators and improvers of technology on a pre-programmed assembly line but maintaining a social identity that is seemingly at a higher technological level. This ostensible identity in turn contributes to their behavioural consciousness of desiring more people to use health technologies. However, the source of this "naturalness" and whether there would be more problems in the power relationship, remain key considerations for more research.

Aspects of health technologies that exclude older people (or could be improved for older people)

After reflecting further on their health technology products, the technology professionals came up with a list of aspects that were not age-friendly for older users, instead of blaming their low acceptance on unaccustomedness and external factors. They identified some elements that could be improved for older people if companies were more considerate of older users, or if they could

receive more feedback from older users. Still, they indicated that some areas were impossible to make changes.

Technology workers suggested that they can introduce improvements for health technologies by simplifying the operational processes in UX design, making the user interface (UI) as clear as possible, lightening the weight of wearable devices, making the technology more fashionable to reduce possible stigmatisation, enabling a better fit between health technology and the living environment, and adding caring functions to the health technologies.

> *"All we can do is make the interface as clear and concise as possible and make the operational steps as brief as possible. If older users were asked to fill out many pages of personal information, there is a high possibility that they would quit midway."*
> *"Maybe they want to change the colour and designs of the wristband based on what they're wearing. We've not done that yet, but we hope to look at it as a fashion, making it less obvious and less stigmatised."*
> *"Some adaptations can be made in the medical care, such as adding after-care features. For example, when an older person makes a medical appointment and leaves test results, our app can proactively ask about the treatment effect and provide more health support."*

Technology workers admitted that it may be tough to actualise these improvements, as they may pose other problems than technical difficulties. For example, the variability of appearance can complicate the technology, and more caring functions may require the collection of more data. These new problems call for further coordination among technology workers.

Technology workers also mentioned aspects of health technology that might be able to be improved for older people but are not within their purview, such as accelerating the local infrastructure construction to support the use of health technologies, socially inculcating the concept of using health technologies, lowering the price of technological products or requesting more government funding for them.

> *"Older people may find these technologies too expensive and not conceptually acceptable; or in rural areas, the infrastructure is inadequate to support these technologies. The government and other social sectors need to do a better job of securing the use of health technology for older people."*

In addition, technology workers identified situations in which older people and health technology are completely irreconcilable, by giving an example of an older adult who did not want to use the health wristband at all. This example may partly resonate with caregivers' characterisation of older people as "stubborn", but it is not known whether there are underlying historical and psychological dimensions of technological pessimism behind this steadfast and hard-to-describe refusal.

> *"I remember one of my clients, who just doesn't like things on her skin. When we tried to put the wristband on, she just wanted to take it off. We know she had the need to use it but it's really upsetting her and making her stressed."*

In giving this example, the person also mentioned that because of the denial of technology, the older lady was in tension with her caregiver who hoped her to

use the wristband, because the caregiver was reluctant to undertake a part of the caregiving responsibilities that “could have been carried out by the technology”. In this case, health technology changes human relations, but the responsibility of old age support cannot be reconciled by technology workers through the development and improvement of technology.

8.3 Technology workers’ views on older people’s participation in the development of emerging health technologies

The technology workers were then asked about their views on the involvement of older people in the development of health technologies and the role they play in it. Given the fact that some technology workers had no exposure to older adults in their work at all, we started with the participation of all age groups, and then further investigated the participation of older people, the reasons for the lack of participation, and the outcomes of older people’s participation in emerging health technologies.

The participation of all age groups

Only a minority of the technology workers interviewed made it explicit that their companies’ development of health technologies included a component of public participation. Others confirmed the closure of the companies’ technical production, i.e., technology testing and feedback collection are conducted in-house or eliminated sometimes due to the low demand for marketisation of the products; some people lacked communication and understanding of other departments (especially on the UX side) because of the task-oriented nature of their work.

“I have not heard of our company recruiting the public for technical testing and group discussions. Our company’s technical production complies with the arrangement of our superiors, and I don’t know if they don’t have a sense of public participation, or they think it’s a waste of time and cost and not necessary.”

The technology workers who were more informed about public participation referred to several forms of participation in different stages of health technology development, including comparison of prototypes at the beginning of the design, online and offline surveys during the design, pre-market trials of the technology, controlled trials of multiple products after they have been launched in the market, data donation from users, and long-term evaluation of the technology use (like ethnographic studies of technology use, with on-site observations, user data collected by the technology, surveys and interviews with users, their family members and other stakeholders). They did not consider commenting on health apps in the app store as a valid form of participation because most of the comments were very personal and confusing.

“Our company sometimes makes different prototypes very quickly at the beginning of the design and invites potential users to compare them. Sometimes we do A/B tests after we launch the products, where users are randomly assigned to two groups to use A or B products and we will collect their feedback... I’ve seen my colleagues demonstrate the results. They played a video for the whole company and the participants said in the video what didn’t work well with our app and what features could be added.”

“There are usability studies in any development of technology. For example, I did my first usability study in a school. I let the participants

use the technology until they learned how to use it, and then I left the products with them for like three months. Every month I'll check in and see how they how they're doing... There were always problems that never happened in my lab. So, we learned how to fix all of this over time during the three months of testing."

These technology workers also described their companies' selection of participants. The first was targeted users of health technology products:

"For example, if our current product attempts to enhance the control of blood glucose targets in people with type 1 diabetes, we will only select families with type 1 diabetics for testing."

Secondly, they indicated that they would deliberately select users who are not proficient in the use of digital products to get more advice:

"We would prefer those who are not skilled in technology to have a trial. If we choose someone who uses a mobile phone every day, he may be comfortable with our app at once and think the design good enough."

However, the technology workers also commented that there were times when participants were not entirely out of their selection and could not perfectly match their expectations. They would consider convenience samples whose access and informed consent are easy to obtain; it also occasionally depends on the willingness of the participant to sign up.

"I got a fund from the council, and they had a network of schools. As in one school, I can have access to 30 students and I have support from their families, it's an easy setting for me to test a new piece of technology... Each school identified the proper students with one-to-one meetings and ensured the technology would not cause anxiety to them."

"Sometimes we would pay for the participation, and those who are interested in participating are usually from economically disadvantaged groups, such as single mothers with many kids at home."

It is worth pondering whether such recruitment intentionally excludes certain groups. For example, people who are more accessible to technology companies may have had more advantages in society in the first place (e.g., students involved are likely to be from families with better economic status, according to the technology worker interviewed). This could potentially lead to a wider gap between them and groups without access. Moreover, considering the motivations for remunerated participation, it is necessary to examine the inducement of payment and the authenticity of the feedback if the participants regard participating solely as a means of earning money.

Older people's participation in the development of emerging health technologies

Predictably, there were even fewer companies that had older people as participants in the development of health technologies, although most interviewees recognised the need to involve older adults and agreed that older people are key users of health technologies who can provide a special perspective on technology design.

“I think older adults have a lot of interesting perspectives on how to improve certain things, so it’s a shame not engaging them. By including older adults, you’ll probably be able to implement improvements into your app that also benefit younger people or people with other limited capabilities who aren’t old. So I think it’s kind of a lost opportunity to make a better product or a better app.”

In cases where older people were recruited, the technology was often targeted exclusively at older people or would be settled in care homes. One designer of health technologies presented the concept of “co-design” and failure experience-oriented participation of older people, implying that when older people are predetermined to be the target users of the technology, they are also spontaneously assigned the role of co-designers, even with the responsibility of enhancing the success of the technology.

“Co-design is cooperative design with the end users and other stakeholders. The actual end users are mainly older people living with chronic pain, so we take our design ideas to them and get them to evaluate them... I think it needs to be done more, because I think quite often, people in labs will come up with fantastic ideas, but they never actually try it with the end users, and then they get horrible outcomes.”

Similarly, some technology workers suggested that paying older adults would boost their motivation to participate and that as older participants were regarded as co-designers, the payment was more like a normal income from labour than a bribe or commission for them to put in a good word for the products to promote the products in a prearranged manner.

“The participants would get paid and they were relatively interested, feeling really special that their opinion is being heard in technology development... They are also very happy to disagree, so I think the payment wasn’t too much of a factor.”

However, it was also noted that assigning older people the role of co-designer may increase their stress and discourage them from participating. In response to the older people interviewed who felt they were “not good at speaking”, “not knowing what to suggest” and “not being proficient users”, technology workers observed:

“Engaging older people is not expecting them to take on responsibilities and come up with novel suggestions. I prefer to simplify the engagement into daily chats and reduce older people’s pressure to participate.”

Those who involved older people in technology design mentioned two formats they took before: doing the online survey and collecting feedback with conceptual videos. They appreciated the interactivity of watching videos and the depth and variety of advice that could be gained from face-to-face conversations, in exchange for a greater investment of time and work.

“We worked with artists and storytellers to make films like animated cartoons with basic concepts of our technologies, then we would ask questions on what they saw. We did a lot of testing to make sure people could understand it and people seem to engage with it mostly.”

Technology workers who conducted the online survey referred to the constraints resulting from the COVID-19 pandemic during the past three years. They considered web-based surveys to be an effective way to involve older people in the context of limited circumstances and time but recruiting from the Internet created a less representative sample of older participants as they were much younger than the expected average. They also pointed out that some online surveys were outsourced to third-party vendors, which led to discrepancies between expectations and outcomes.

It can be seen that there are still many areas of uncertainty and a need for further optimisation concerning older people's participation in the development of health technologies, including the extent of involving older people, how to position older participants, how to incentivise participants, what kind of recruitment methods to use, how to ensure diversity and fairness when selecting participants, and what to achieve through older people's participation (whether the participation is a formalistic walkthrough or a standalone feedback project). These issues may not be tackled independently by the UX department of technology companies but require further openness of the technology environment and more discussions among stakeholders.

Reasons for excluding older people and challenges of including them

Employees of technology companies that did not include older adults explained the reasons for doing so or the challenges they encountered in trying to include older people. Firstly, some technology workers were convinced that the time and cost required to include older people would be too much. They argued that in an era of rapid technological advancement, the involvement of older people can retard the upgrading and industrialisation of technology, which is to the disadvantage of for-profit technology companies.

“Involving people with a variety of ages in product development can be helpful, but we rarely invite older people to participate. Our design team and the product manager will weigh the pros and cons and will exclude older people if we focus more on time efficiency.”

“Older people’s participation may make the health technology more suited to them, but it could slow down the development of the technology because they are lagging behind technologically and we need to spend more time explaining the concepts of new technology and explaining participation to them.”

Secondly, some technology workers indicated that they did not have access to older people. Not only was their team dominated by young and middle-aged people, but in technology promotion, the first to get relevant information and have an interest in participating were also young people, and they seldom even had conversations about technology with their older family members.

“Our busy pace of life dictates that we are likely to come into contact with ‘corporate slaves’ under 40. People over 60 are all retired and completely out of my social network.”

“I didn’t have access to older people, so I didn’t do any testing with them.”

Technology workers who had some contact with older people complained about the difficulty of communicating with them, but this was not quite the same as the complaints of caregivers. Caregivers’ complaints of “stubbornness” and “incomprehensibility” came from emotional displays of living closely to older people for a long time; technology workers’ descriptions of “difficult to

communicate" were due to unfamiliarity, older people's deterioration of physical functioning and a lack of technological literacy, as they assumed. There were also differences in what they needed older people to do and how they interacted with them.

> *"The older people I worked with had some deterioration in their speech or were depressed due to declining health. When we talked to them, they could not fully understand or were not willing to communicate with us, so we sometimes tended to communicate with their caregivers."*
> *"I think one of the challenges for me is communicating about technology, such as explaining to older people what data is collected. You need to make sure that they fully understand the privacy connotations and I think that's quite difficult."*

In addition, technology workers identified ethical challenges in involving older adults. One of them who recruited students with disabilities found that including "vulnerable groups" in technology development required extensive ethical approval from themselves, their families, teachers, schools and the council. She had to have public liability insurance and the technology was subjected to sophisticated safety tests before being sent around students. She assumed that these challenges would apply equally to the involvement of older adults:

> *"...It will also be difficult when it comes to older people. There is a lot of research that we need to do before we are able to catch it to them properly."*

Technology workers also indicated that they need to overcome cultural challenges when confronting older adults from dissimilar cultural backgrounds.

They mentioned that when visiting the houses of Asian older adults for observation of technology use, they were forewarned about some taboos to avoid insulting older adults and to build harmonious relationships.

> *"We worked harder to make sure that older people are okay with strangers entering their home. There was a lot of pre-work before even meeting anyone and there's certain things you need to do like removing the shoes and bowing and being very courteous to cultural customs."*

Flinching away from diverse cultures and beliefs was also one reason for technology workers to exclude certain groups of older people. One of the UX designers reflected on discovering that 95 per cent of people involved in the technological participation projects she had undertaken in the UK were white people, while ethnic minorities had been largely ignored. Technology workers were not aware of the cultural differences between them, nor were they able to understand the impact of cultural factors in the use of health technology by older people from different regions and ethnicities.

Effects of older people's participation in the development of health technologies and technology workers' role in the participation

Whilst a small number of technology companies have involved older adults in the development of health technologies, the effectiveness of the participation remains in doubt. When asked further about how they would deal with the feedback provided by older people, there were hesitations and ambiguity. Only one of them was fairly positive about the usefulness of older people's suggestions and believed that his company would take them seriously and make improvements accordingly.

"We would listen to their comments. If we recruited a hundred older people and they all disliked a certain feature, we would definitely change it, no matter how good we think it is. Our company tracks the registration and usage rates of the products, so we will be held accountable if we lose too many users."

It sounds like the positive action on older people's feedback was not necessarily prompted by the technology worker's subjective judgement. It not only required massive energy (the collective advice of a hundred participants) but was also driven by the fear of being held accountable. This kind of action was also "task-oriented", as the effects of participation were conditioned by the involvement of a broad range of actors, in which the technology workers were entrusted with the role of "implementer". This also partly explains why there were few responses from app developers in the pilot study.

Technology workers who thought the effectiveness of older people's participation was mediocre doubted the usefulness of their opinions. They found that older people would bring up interesting topics that they had not considered before, but many of the topics were not pertinent to technological improvements, which may be why some technology workers felt the inclusion of older people was "a waste of time".

"I think the subjects are interesting but most of the time it is not relevant. What we got are 'facts' about older people's lives and what they want from technology (note: not just about the technology shown to them, but about some other technologies). It is more a fact-finding mission, but not always useful to us."

Technology workers also contemplated the complexity of implementing the feedback given by older people, as it is not just a two-way communication of collecting opinions and taking them on board, but when they received the feedback, they would go through a process of constant communication upwards and downwards and rolling up suggestions to plan for the next steps. This process is like a filter. Given the feasibility and technical constraints, the amount of feedback raised in older people's participation that can be translated into technical performance by engineers will be minimal, or potentially be distorted.

> *"After the transcribing and analysis, we would make reports and presentations of the feedback. It meant showing our product managers what we came up with and then they would decide whether to show the presentations to other engineers at the company. When we would show engineers, we'd all have like a discussion on how it can be implemented into a capability and what it would look like."*
>
> *"I have seen some of our findings manifest in certain ways into the capabilities but there are a lot of constraints that they cannot do technically as engineers. I think people think technology is far more advanced than they really are. Some of them are not actually feasible."*

The technology workers interviewed emphasised here the leading role of the technical team as a whole (and in particular the decision-makers rather than themselves individually) in the process, like "it is up to the product managers whether older people need to be involved and whether their feedback will be adopted", meanwhile diminishing the agency of older participants and themselves.

Another developer attributed the difficulty in making improvements to the late timing of participation. She advocated the idea that technology participation should be performed early, incorporating older adults while the initial model was still very basic, in order to increase the effectiveness of participation and accelerate the process of updating the technology:

> *"User participation should be as early as possible. Actually, in the beginning, you make everything very simple, so that upgrading and fixing it can become easy. If you start with a full and complete system, and there're so many features in it, it's very, very hard to update it quickly."*

8.4 Technology workers' views on health technology systems in comparison with those of older people and caregivers

Other ideas that technology workers had about health technologies centred around the whole social system associated with technologies. A number of those ideas were specific to technology workers and consistent within this group, which were divergent from or barely mentioned by the older adults and caregivers interviewed in my research. Some examples include that technology workers developed more management-oriented (rather than user-oriented) views on data privacy, and they saw the digitalisation of healthcare as an inevitable trend and identified a need to bridge the resulting digital divide. In addition, their subjective view of older people differed significantly from the concept of "vulnerable groups". The following themes are arranged in order of importance as mentioned by technology workers.

Data privacy – considering laws and governance

Technology workers' considerations of data privacy were much different from those of older people and caregivers, concentrating on how laws and policies dictate privacy protections and how technology companies manage user data. Those working in the UK cited the General Data Protection Regulation (GDPR) as a guide to design the "terms and conditions" of health apps and online healthcare platforms, and technology workers said that they had minimised the collection of user data based on it.

> *"We need to comply with the laws about data privacy, then GDPR is a protection for personal data."*
> *"It has to have the privacy statement. It's compulsory. I mean, anybody who is working now in the EU has to comply... We're not gonna use the data, even though this kind of data would be very valuable... I don't think it's ethical to use their data unless it is to help them live a better life, which is what the technology is designed to do."*

However, technology workers indicated that in many cases, access to services must entail a partial compromise on the disclosure of data privacy. One health app developer provided an example that if apps for ordering prescriptions did not collect personal information at all, one person could sign up for multiple accounts under fake identities and would easily exceed the purchase limit for a particular drug (as medicines can be toxic or even fatal if taken in overdose), which could lead to illegal conduct. Therefore, he considered the collection of personal information to be an effective measure to avoid similar occurrences. It has been observed that some of the older people interviewed were willing to sacrifice some of their privacy in exchange for a guarantee of safety, so there appears to be a tentative agreement between older users and technology workers in this regard.

Technology workers with experience in both China and the UK[23] found that Chinese companies had relatively weak protections for data privacy. Although this is consistent with some Chinese older people's attitude of not caring about privacy breaches, technology workers still believed that it was essential to establish privacy safeguards, as personal data could imply extra information that users do not want others to know. Hence, they expected the government to put in place better management tools and their companies to protect user privacy as much as possible, for example by being more explicit about the privacy policies in the health app.

> *"There is less resistance to accessing data in China, but if the data is obtained unlawfully, for example, a doctor privately sells patient data to technology companies, I am strongly against it. Though this facilitates large-scale demographic analysis, it is still unethical."*
>
> *"Sometimes older people seem to just be less aware of what data they're sharing and the consequences it can have as well, but people can infer a lot from data that people don't realise. For example, when you are not using the health sensor at home that is always turned on and someone is monitoring that, they would know that the house is empty... I think the companies should communicate those things (note: terms and conditions) in a more straightforward manner."*

Concerning the privacy policies of technology products, technology workers had the same opposition as older people to the "one-size-fits-all" approach (i.e., if the user did not agree to the policies, they could not proceed). Technology

[23] Interviewees include Chinese people working in the UK and British people with work experience in a variety of countries. The interviews took place in the country where they were living at the time.

workers suggested that users should be given more options and be offered appropriate services even if they did not consent to the collection of certain data.

It can be deduced that technology workers felt responsible for users' data privacy, but as they were not in full control of the data themselves, they were appealing for legal and regulatory refinements. How to divide this responsibility, such as how much managerial freedom can be granted to technology companies within the bounds of the law, can be a topic that is always up for discussion in the course of technological development.

"Digitalisation of healthcare is an inevitable trend"

The digitalisation of the healthcare system was perceived by almost all the technology workers interviewed as a positive development and an inevitable trend, which is contrary to the thinking of older people who accept the deterioration of ageing and refrain from the use of technology. Technology workers spontaneously recognised that health technology "is generally a good thing", because it can make life better.

> *"I feel like, eventually wearable technologies will be such a normal thing like you're connected to everything, because we are moving a lot faster in the technology world than we did ever before, especially with AI. It's constantly learning from you about your ability and your needs. So it's going to make your life easier. Why wouldn't you adopt it?"*

Several technology workers emphasised their sense of vocation in the digitalisation of health technologies. They were upbeat about their obligation to

contribute to digitalisation and provide guidelines for older people on how to live a healthy life:

> *"I developed a tech to make people a lot easier, so I feel like it's my job to provide them with the solution that works for older people."*

Some others considered themselves as a tiny segment of the inevitable trend and sometimes wondered whether their work would help and influence technological development, which seems to occur "as a matter of course" with evolvement of the society (echoing Ogburn and Thomas (1922), which discussed the idea that inventions are inevitable in social revolution), and technology would spread naturally and socially. Their inherent implication remains that it would be better for the public to use the technology.

The common belief among technology workers that "digitalisation of healthcare is an inevitable trend" may derive from their companies' objectives and the media discourses to motivate their work. It was unsurprising that they thought about technological development more from the companies' standpoint than from the users' perspective, embracing "facilitating the user" as an unquestioned preconception and a pretext to rationalise companies' goal of making profits.

> *"Digitalisation is not only a convenience for the public, but also a big market and a profitable thing for companies. A lot of industrial interest in remote working was fuelled during the COVID-19 pandemic and there is still considerable room for profit in digital health."*

Technology workers' positive vision for digital health technology and the expanding market left them hopeful about the potential for older people to become skilled technology users in the future. They assumed that older people in the future could naturally adapt to the technological society through environmental penetration (possibly ignoring the simultaneous or even faster development of technology and the inequalities caused by technologies), and even began to worry about the excessive use of health technology by older people in the future while losing their interaction with humans.

> *"Older people's detachment from humans and human care worries me. This might be a more far-future kind of thing or might never happen. But it does worry me that it could possibly happen, and the older people are just locked up in their flats and new technologies just do all their entertainment, all their care, and they miss out on human interaction with other people."*

Digital divide

The idea of the inevitable trend of digitalisation has also given birth to discussions about the digital divide. The concept of the digital divide (or digital gap) originated in the United States, referring to the discrepancies in access to and use of digital products by different groups in society in terms of economic capability, race, gender, age, etc., and symbolising the imbalance in the development of various regions (Hu and Zhou, 2002). In contrast to older people who did not speak of such gaps, technology workers placed the topic in a significant position, comparing the access to, interest in and familiarity with health technology between older people and young people and among older people.

Technology workers contended that the digital divide would always exist, but they could try to bridge the gap with more effort. For the gap between older and young people, technology workers called on young people to recommend and help older people learn technologies, especially those that indeed improve their quality of life and support their physical and psychological well-being.

> *"Ideally, the digital divide can be bridged through outreach. Some health technologies are really helpful for older people, and if young people know more about them, they should advise older people to learn."*

For the gap among older population, technology workers believed that cross-promotion would work well to reach a higher level of collective acceptance. One of the things they can do is to make the technology aligned with their collective needs, such as making it easier to use and creating incentives.

> *"My initial observations would be that there are some older people who love it. And then others just have no interest, and they might get left behind to a certain extent. But they can exchange ideas. If the technology is made to be very usable and user-friendly, I think older people are becoming more accepting of it."*

Technology workers realised that the digital divide was actually an economic and social divide. If younger people (or people with higher socio-economic status) always adopt new technologies faster than older people (or people with lower socio-economic status), this divide will likely be widened with technological advancement, resulting in increased inequality in the use of technology. Technology workers concluded that throughout history and societal

progress, addressing this inequality required the involvement of various social forces, and there was a limitation of what they could do.

> *"The wealth gap could definitely be an issue, with the people who have lots of money living like perfectly technologically maintained lives, and other people not being able to afford anything. But I don't know how much we can do about the technology, because we're not economists, we're not politicians."*

From this quote, we can identify some limitations of the existing literature on older people's acceptance of technology. Researchers tended to think about the purposefulness of older people's adoption and the functionality of technology from a unilateral perspective of older people or technology, but social forces like economists and politicians who also shape the development of technology and public acceptance of technology were always overlooked. It may be worthwhile to put more influencers in future research on the relationship between the public and technology.

Older people as target clients instead of a resource-disadvantaged group

In contrast to caregivers' well-grounded acquaintance with older people through living together, technology workers (especially those with little contact with older people) gained most of their knowledge of older people from the service philosophy of the companies' products and the sociotechnical imaginaries (defined by Jasanoff and Kim (2009) as "collectively imagined forms of social life and social order reflected in the design and fulfilment of nation-specific scientific and/or technological project"). They rarely proactively considered older people as a vulnerable group – although they recognised the differences in the accessibility and availability of technology between older and younger

people, they were inclined to approach older people as target clients in need of healthcare resources in the way of business and preliminarily refuted the issue about the inequality of resources brought about by technology (or inequalities created by technology, as distinct from the differences between accepting or not accepting technology mentioned above), or argued that such a possible inequality did not originate from technology and that the providers of technology and service should not be blamed.

> *"For GPs in the UK, there is no difference between the service provided by a telephone appointment visit and an online appointment visit. Their income will not be increased by more people booking online, so they are not going to be more favourable to picking up online appointments and cut down appointments by older people who don't use technology. Health technology is not squeezing the resources available to older people."*
>
> *"When there was no digital technology and everyone uniformly booked medical appointments by calling or walk-in, there were also variations in the speed of access and queues at hospitals. I don't think the use of health technology will reinforce this situation, not to mention that there are caregivers to help non-users of technology."*

It is very interesting to see technology workers' reflections in terms of the benefits to hospitals and healthcare systems. It is as if they have inadvertently changed the technology-centred paradox and transformed the problem of "fewer slots of appointment without health technologies" to other technology users and caregivers who "have a responsibility to help". This "dilemma of inequality" is probably related to the social identities of the respondents and for technology workers they were trying to justify their work through the refute.

They still insisted that the ideal relationship between older people and health technology was broad acceptance, to achieve a notion of a “win-win” situation, whereby older people “win” a better life through the use of health technology (which is still questionable according to interviews with older people) and technology companies “win” profits from their business practices. They were almost completely blind to the images of older people from the caregivers’ perspective and how these images were entwined with health technologies. They considered older people as flat “clients”.

> *“On the one hand, we have to focus on older people as the target clients; on the other hand, if some older people are less interested in adopting the health technology, we can turn to their friends and children and ask them to promote our products to older people. As long as these people develop stickiness and passion for our products, there is a chance to attract older people around them.”*

As a result, technology workers urged for more social service amenities for the sake of wider adoption by target customers. They agreed with the concept of “technology as a solution”, but also recognised the need for more complements of this “solution”, such as more responsible human caregivers, more advanced healthcare services, more comprehensive infrastructure, and a social environment that is more open to technology.

Chapter 9: Discussion

In the empirical chapters 5-8, I have presented findings on three groups of interviewees. This chapter will discuss these findings in the context of existing literature to answer the research questions in detail, present the implications of these answers and how they will shed light on future research on the relationship between older people and technology.

The discussion chapter will begin with a comparison of attitudes between older people in China and the UK, pointing out how different attitudes relate to contextual factors. I will then go on to compare the perceptions of three groups of interviewees to open a discussion about interest and inequality in technology acceptance and participation. The third part of this chapter will discuss how different concepts of ageing are co-produced with health technology. Finally, I will focus on how various actors work and construct networks at different stages of older people's technology acceptance and participation. Throughout the discussion chapter, I will draw on the pilot study and interviews to develop the lessons and refer back to specific quotes where relevant.

9.1 A comparison of older people in China and the UK: how and why they are different in their relationship with health technology and what does it imply?

From the findings of older people's acceptance and participation in health technology, we can identify similarities and differences in technological attitudes, decisions and arrangements of older people in China and the UK. In the first part of the discussion, I would like to illustrate how contextual factors of older people influence their judgements about technology, and how

connotations of health technology echo or diverge from the values of older people in both countries.

In this section, I will first present all the differences and similarities in a table and the discussion is based on each row of the table concerning contextual differences presented in section 2.6. These comparable items mainly include the conceptualisation of ageing, the adoption of digital health devices only by Chinese older people, references to mental health technologies only by British older people, the acceptance of other health technologies, understanding of tools for epidemic control, perceptions of data privacy and technological participation. Finally, I include caregivers and technology workers in the discussion. Although there are few differences in their attitudes towards health technology, it is still possible to spot how the contextual factors of the two countries are implicit in their relationship with older people.

Table 2: Differences and similarities between older people in China and in the UK

	Older people in China	**Older people in the UK**	**Similarities**
Conceptualisation of ageing	Raising health awareness; preference to maintain the existing lifestyle; reluctance to retire	Focusing on health declines; demand for new relationships; retirement happens naturally	Having changes in families and relationships
Digital health devices	Commonly used and recognised	Rarely recognised	N/A
Technologies for mental health	Not mentioned	Mentioned	N/A
Health apps	Limited types in use; relying on familiar platforms; developing a close alignment	A wider range of types in use; making a clear separation between “fitness” and “health”	Using health apps for step tracking and telemedicine

	between fitness and health		
Smartwatches	Only one existing user with positive attitudes (but without technical support after accessing the smartwatch); rational analysis	More existing users (most involved in the EIDS project and received a free Fitbit and technical assistance); emotional appraisal	Technical support needed
Technology for ageing in place	Reliance on human carers and policies	Possible reliance on technology	High self-esteem
Tools for epidemic control	The Health Code: most people had experience of using it and spoke out freely about their views on it	COVID Pass: no one actively mentioned it and few comments on it – people may see it as a surveillance tool	N/A
Attitudes toward data privacy	Little to no concerns	Much more concerns	N/A
Participation in the development of health technology	Conservative about participation	Much more positive intention to participate	Limited experience; unknown effectiveness
Relationship with caregivers	Caregivers intervene more in older people's relationship with health technologies (e.g., purchase and help)	Caregivers intervene less in older people's relationship with health technologies	N/A
Relationship with technology workers	Easier to collect health data	Harder to collect health data	N/A

9.1.1 Different conceptualisation of ageing between older people in China and the UK

At the beginning of Chapter 5 and Chapter 6, I described the conceptualisation of ageing by older people in China and the UK respectively. Older people in

both countries experienced changes in their families and relationships with family members as they got older, but they were different in perceptions of health, demands for relationships and views on retirement. To make it specific, Chinese older people wanted to stay healthy through exercise, self-care and regular check-ups, while British older people emphasised their health decline; Chinese older people were satisfied with the current state of their lives and tried to maintain relationships with old friends, whereas British older people wanted to make new friends; Chinese older people were reluctant to retire, but British older people saw retirement as a natural occurrence.

These distinctions from the interviews expand Warmoth, et al.'s (2018) single argument that Chinese older people have more positive attitudes towards ageing than British older people. Firstly, Chinese older people's active maintenance of health echoes Pan et al.'s (2019) statement that Chinese older people are very conscious of physical functioning in promoting positive perceptions of ageing. Although Zhang (2021) noted a lack of healthy lifestyles among Chinese older people based on 2011-2012 data, Chai (2022) found that their health literacy and behaviours have been enhanced since the COVID-19 pandemic, which may be due to the extensive health-related media outreach and the collective health governance. Secondly, the interviews revealed a correlation between the need for new relationships and perceived loneliness among older people in the UK. Victor and Yang (2012) demonstrate that older people in the UK are more likely to feel lonely than middle-aged people, which is associated with the loss of family and friends, and that high-quality social relationships are protective against loneliness. Several cross-country studies found that people living in individualistic countries are more vulnerable to loneliness than those living in collectivistic countries (Heu, van Zomeren and Hansen, 2019; Barreto, et al., 2021), which may be a reason why British older

people need new relationships more than Chinese older people. Thirdly, China's reports on ageing mentioned in the literature review view caring for older people as a "burden" on young people (p.63), but Chinese older people's reluctance to retire may be a challenge to this discourse. Some literature introduces the concepts of bridge employment and indicates that participating in a certain amount of labour after retirement contributes to health and economic security (Yin, et al., 2022), as might be expected and attempted by Chinese older people. Conversely, interviews with British older people did not identify their significant resistance to retirement. This is probably because they are relatively free to choose when to retire (while China implements the mandatory retirement policy, p.112) (Loretto, Lain and Vickerstaff, 2013). Although the COVID-19 pandemic may have changed their retirement plans (p.170), some older people accepted that they had reached the "right" age to retire (D'Angelo, et al., 2024).

9.1.2 Differences in older people using health technology between China and the UK

The conceptualisation of ageing and attitudes to health technology are closely linked. For instance, the way that small digital health devices are commonly used and recognised by older people in China but rarely recognised by older people in the UK reflect differences in how ageing is conceived in each country, as well as their perceptions of the healthcare system. According to interviews, older people in China have increasing health awareness and it can be a reason for them to accept digital health devices — they confirmed this when speaking of the motivation to use them. Considering the social structure, China has a large older population, and despite the government's continued efforts to improve the healthcare system, there are still problems of insufficient and unequal healthcare resources (Chen and Liu, 2023). Older people tend to

normalise chronic disease, downplay their need for professional healthcare and avoid using up limited medical resources (Zou, Fitzgerald and Nie, 2020), and digital health devices thus become an alternative to medical care. Even if there are sufficient healthcare resources, Chinese older people are not willing to go to the hospital frequently but tend to control diseases themselves, because hospitals are culturally associated with “inauspiciousness” and “death” instead of “healing” and “hope” (Siu, 2021). Based on the findings of my interviews, Chinese older people have constructed the cultural connotations of digital health devices based on their expectations outside of hospitals, that is, digital health devices are “their own” (independent and equal), “readily available” (no need to pay extra in use) and “easy to use” (no need to be subservient to experts) health technology that helps them to “avoid misfortunes” (fewer trips to the hospital). In contrast, older people in the UK acknowledged the convenience of a simple health check in the GP and do not have a strong aversion to “going to the hospital”, which led to the disappearance of the need for home digital health devices. Although it was found that clinicians in the UK occasionally encouraged patients to use home monitoring devices, many British people remained sceptical about the devices and were accustomed to having basic check-ups from primary care, and even concerned that such devices may increase workload and responsibility of clinicians (Bostock, et al., 2009).

Technologies that can help with mental health and wellbeing were only mentioned by older people in the UK, indicating possible differences in older people’s status of mental health, perceptions of mental health, and availability of digital mental health tools in the two countries. A comparative study of the mental health of young people in the two countries during the COVID-19 pandemic suggested that the Chinese culture of collectivism and restraint of

emotions would help decrease loneliness and mental disorder symptoms (Liu, et al., 2021). Therefore, Chinese older people may have relatively rich spiritual lives and positive attitudes towards life, whereas British older people are more in need of technology to support their mental health. The two countries also have differences in traditional perceptions of mental health. China has a late start in recognising mental health issues and is still exploring ways to improve its mental health service system, while the large population base and disparities make it difficult to manage the system (Liu, et al, 2011). Compared with British people, Chinese people are more inclined to equate health with physical health and use health technology to control only the physical deterioration, but downplay mental illnesses as emotional issues or normal difficulties in life, hide, stigmatise and stereotype mental health problems (Ngai, et al., 2014; Kolstad and Gjesvik, 2014). There are also limitations in digital mental health services in China, as some commonly used tools in Western countries have not yet been developed or tested (Zhang X., et al., 2021). Conversely, the British had psychological health education and universalisation much earlier, integrating it naturally into the healthcare system (Hannigan and Allen, 2006). There were national programmes against stigma and discrimination to mental illness in the UK, and public attitudes towards mental health have improved over time (Robinson and Henderson, 2019). These comparisons may be the reasons why only British older people incorporate mental health technologies into interviews.

Health apps and smartwatches were mentioned by older adults in both countries, and there were similarities and differences in their attitudes and usage patterns. For health apps, British older people use health apps in a wider range of categories than Chinese older people and are more exploratory of unfamiliar apps; they do various kinds of exercise and make a clear separation between “fitness” and “health” (being proactive about exercise is not always

associated with staying healthy, but it is just a hobby or a way of passing the time), which may point to the problem of integrating health and fitness in the Apple App Store. In contrast, Chinese older people have relatively limited use of health apps, and they tend to rely on familiar platforms, for example using WeRun when fully grasping the use of WeChat and they are considerably less likely to use and have positive attitudes towards standalone apps for sleep and diet. They develop a close alignment between fitness and health (exercise is all about staying healthy), and it seems that walking fulfils the basic need for exercise. These differences between older people in the two countries may be related to socio-technical discourses and social or (self-) constraints on older people, as older people in China are likely to be exposed to an integration of national fitness and national health in policies (Zhang W., et al., 2021) and tend to be culturally conservative without the encouragement to explore new things, which is confirmed by other research regarding Chinese older people's adoption of health technology (Jiang, et al., 2022; Li, et al., 2023). However, British older people have a strong sense of autonomy and control in exercise (Hardcastle and Taylor, 2005) and may be relatively open to new things. This is similar to how they think about changes in ageing, as they are willing to embrace new environments and relationships rather than being tied to family or old relationships.

Older people in China or the UK who gave positive evaluations of smartwatches were in similar conditions — the smartwatches were acquired through technical support programmes (those in the UK who involved in the EIDS programme received a free Fitbit and technical assistance; the existing user in China also received the smartwatch free of charge through a company's promotion though without support afterwards). This similarity reflects the importance of technical support in older people's access to and use of smartwatches. Current research

on older adults' use of smartwatches focuses more on the accuracy of smartwatches and older adults' need for functionality (e.g., Martinato, et al., 2021; Yi, et al., 2023), but how technical support programmes are laid out has yet to be investigated, which may help to further understand the support needed by older people from different contexts when they accept and use health technologies. I have already found in the pilot study that older people tended to be moderate and euphemistic in their comments about health apps, but British older people were outspoken in their criticism of smartwatches in interviews. Some of them gave very emotional comments (*"The Fitbit is gonna be thrown out the window"*, p.176), while Chinese older people provided relatively rational oppositions. Lin and Wu (2024) suggested that polite or subtle expression by Chinese people is a construction of harmony and cooperation, but it may undermine the stability of actual attitudes towards technology.

For ageing-in-place technologies such as home sensors and healthcare robots, Chinese older people demonstrated more reliance on human carers and policies, while British older people thought about reliance on the technologies. The interviews hint that with China's large population and low labour costs, most Chinese older people do not feel the urgency of deploying these technologies but see them as future technologies at the policy level; British older people had a higher level of acceptance of these emerging technologies but were also afraid of dependency and stigmatisation brought by them. Older people in both countries had high self-esteem, which is highly related to body image and functional abilities (Baker and Gringart, 2009) and formed the main reason for resisting ageing-in-place technologies, but older people in the UK were more concerned about the privacy issues associated with these technologies, which will be further discussed in section 9.1.4.

9.1.3 The Health Code and the COVID Pass

China's Health Code and the UK's COVID Pass were the tools for epidemic control in the two countries during the COVID-19 pandemic, and their technological logic is both to collect a certain amount of personal information to give the user a QR code as a pass or to prohibit pass. However, it is interesting that in the interviews, Chinese older people regarded the Health Code as the most important health tool, and most of them had the experience of using the Health Code and spoke out freely about their use and views on it; but the COVID Pass disappeared from the interviews with British older people – none of them actively mentioned the COVID Pass as health technology, and apart from a small amount of feedback I got in the pilot study, I did not get any comments on it. This difference between older people in the two countries can be related to differences in their usage, the management of the QR code during the epidemic, the platforms of the tool, and perceptions of data privacy.

During the Covid-19 epidemic, the use of the Health Code was ubiquitous. According to China's statistical report on Internet development, the number of people who applied for a Health Code in China reached approximately 900 million, accounting for more than 60 per cent of the country's population (CNNIC, 2021). The government took advantage of the prevalence of the Health Code to develop the big data industry and the digital transformation of the healthcare sector (CNNIC, ibid). In the UK over the same period, the NHS App had around 10.4 million users (the users of the COVID Pass are undoubtedly smaller than this number)[24], which is roughly 15 per cent of the UK population. The difference in coverage of the two tools would surely lead to a difference in awareness among the people in the two countries.

[24] See: https://www.gov.uk/government/news/more-than-10-million-people-now-using-the-nhs-app

This difference in coverage may in turn stem from discrepancies in the intensity with which the tools are used for regulatory purposes. During the pandemic, it was compulsory for people in China to use the Health Code whenever they needed to travel, as the government allocated staff to check the Health Code in almost all public places and on public transport as a “mass social mobilisation under the rhetoric of patriotism” (Cong, 2021). Interviews with Chinese older people also revealed a high level of compliance with government regulations and agreement with the government’s assertion of using the Health Code for “collective good”. In the UK, however, the COVID Pass was more commonly used for international travel than for domestic events, and the government website stated that “some events or venues ‘may’ choose to ask for the NHS COVID Pass” (UK Health Security Agency, 2021). Therefore, people living in the UK were not mandated to use the COVID Pass. For older adults who are not active socially, as they indicated in interviews, there may be no occasions to use the COVID Pass at all. A rapid review of public responses to the COVID-19 health certificate found that most people in the UK considered it as a surveillance tool and that there were inequalities in testing and vaccination uptake related to education and ethnicity, demonstrating mistrust in the government (Drury, et al., 2021), which is very different from the Chinese situation.

In addition, both the governments of the UK and China considered those with limited Internet access and introduced paper alternatives. Compared to older people in China who could easily obtain paper certificates valid for six months at community centres, older people in the UK needed to require paper copies via the website or phone call. It took several working days to receive the copies,

and they were only valid for thirty days during the outbreak (NHS, 2021), which might make older people reluctant to obtain them.

China's Health Code was mainly structured on Alipay and WeChat platforms, both of which are all-in-one apps that have many functions (including social networking and making payments) and are two of the most downloaded apps in China (Cong, 2021). For people who are accustomed to using familiar platforms, the Health Code had the platform advantage in the first place; for the management of the pandemic, this platform advantage also translated into the ease of data collection (Liang, 2020). Some older people who were not previously users of Alipay or WeChat may also continue to use these platforms after the cancellation of policies related to the Health Code, benefiting from the convenience of other functions. As a result, a successful two-way conversion effect between the platforms and epidemic control was achieved, with some remaining scepticism about apps that were not developed by the government. The UK's COVID Pass was structured on the NHS App, and there were also two supporting apps – the NHS COVID-19 App for tracking close contacts and the NHS COVID Pass Verifier App to confirm the validity of the COVID Pass. It could be observed that in the UK the whole digital system for the control of COVID-19 was built under the healthcare sector (rather than being merged with other digital services). Whilst the introduction of the COVID Pass brought many new users to the NHS App, they may not necessarily continue to use the app for other healthcare services after the COVID Pass closed (the two supporting apps also closed in 2023) (Sukriti, et al., 2023), so the lasting influence of the COVID Pass on British people may be limited.

There are also differences in the collection and use of data between the two tools, although they offer similar privacy policies. The Health Code collected

more personal information than the COVID Pass, such as travel history, and this information is open to health authorities and government agencies for the management of public health (Wu, et al., 2020). The NHS App in the UK, meanwhile, claimed not to use the COVID Pass outside of public place checks in a narrower context[25], as there are strict rules on data collection in the UK. However, older people in China showed that they were more open to data sharing, had more trust in platforms and governments, and were more attuned to the positive effects of data sharing (thinking they were doing good), which may be one of the reasons why they were willing to talk about the Health Code. People in the UK would rather link data privacy with government surveillance and hacking scams when thinking about COVID-19 contact tracing apps, and access to their data by government and health authorities was not acceptable even if it was for the collective good (Williams, et al., 2021). British older people's reservations about data sharing and more concerns about privacy protection can also be seen in their attitudes towards other health technologies, which will be discussed in more detail below.

9.1.4 Differences in attitudes towards data privacy

Chinese older adults had little to no concerns about data collection and privacy breaches associated with health technologies. According to interviews, most of them regarded uploading personal information for the Health Code as a contribution in a collectivist society, rarely cared about how their data would be utilised when using health apps and put the need to sustain life ahead of privacy protections when considering ageing-in-place technologies. Wang and Yu (2015) found that Chinese older adults are less likely than younger people to have a sense of privacy protection. In contrast, data privacy was consistently

[25] See: https://covid-status.service.nhsx.nhs.uk/help/privacy-notice/, past information can be accessed through web snapshots.

mentioned by British older people in interviews. They discussed how to balance the health management and privacy protection of smartwatches, expressed concerns about how health apps may collect their personal information, and covered three dimensions of privacy (physical, psychological and informational) when they thought of health monitors. These all reflect deeper and broader considerations of data privacy among older people in the UK compared to older people in China. However, according to Cannizzaro et al. (2020) and Hirst et al. (2023), younger people in the UK are likely to be more willing to share their personal information and health data than older people and have a higher level of trust in the privacy protection of technology, which contrasts with the generational trend in the Chinese context.

Literature offers some possible explanations for this difference, including education, ideology and trust in government and technology companies. In China, the idea of privacy and the development of data ethics started much later than in European countries (Pernot-Leplay, 2020). The current younger generation has only begun to know about privacy protection, while older people may have difficulty in accepting the concept of privacy after their own values have been fixed. Yang (2022) notes that the concept of privacy protection is associated with individuality and egoism in a pejorative sense, which is not favoured by Chinese people who have established collectivist values. The interviews also revealed Chinese older people's trust in the government and technology companies, partly because the government presented a long-term positive and authoritative image to older people – Zhao and Hu (2017) identified stronger trust in government among older than younger Chinese, as well as more public trust in the central government among Chinese than people in Western countries, while the high trust may derive in part from the blind faith that "the government is doing good for the best interests" associated with the

Confucian culture. Moreover, there are two contradictory perceptions of ageing among Chinese older people, but both of them lead to weaker protection of privacy. One was the establishment of the eldership authority in their family, as caregivers described cases where older people believed that their offspring should disclose personal information to them; and the other was the development of a sense of inferiority in ageing, as older people thought that they have no secrets and nothing to lose when becoming older (Wang and Yu, 2015). Nevertheless, Chinese older people's trust in technology companies and disinterest in data privacy does not mean that technology companies did a good job in this regard. Fu (2019) found that the privacy policies issued by three Chinese Internet companies (all of whom provide digital health services) generally complied with the "Provisions on Protection of Personal Information of Telecommunications and Internet Users" promulgated by the Ministry of Industry and Information Technology (MIIT), but they were not user-friendly because they used technological jargon that were difficult for users to understand, did not mention how they would deal with sensitive information such as health and medical records, and were more about "notification" or "compulsion" than "choices" (this point was also mentioned by older people and technology workers in the interviews). Hence the privacy policies seem to protect data collectors more than the users. Although Chinese older people are not overtly bothered about data privacy, seemingly reducing the urgency of improving policies and laws for them, the conversation about privacy protection may be fermented in Chinese society as the country's younger generation becomes increasingly conscious of data privacy (Lü, 2005).

Conversely, older people in the UK tend to identify "privacy protection" as an individual right and emphasise its inviolability, and they are often critical of the stance of technology companies in developing privacy policies. This is

correlated with a long history of protecting and respecting the interests of the individual. Baker (2001) describes the parallel development of bioethics and human rights in Western countries during the post-war period, arguing that bioethics originated to protect individuals from authoritarian regimes and scientific research without informed consent, whereby authoritarian regimes and blind faith in science would impose terrible conditions on individuals (e.g., being unprotected subjects of research). In recent decades, Western scholars have also been critical of digital authoritarianism, as technological innovation can lead to greater authoritarian control and abuses of human rights (Dragu and Lupu, 2021). This explains British people's greater concern about privacy issues and more vigilance about data collection than Chinese people. The UK and EU Parliaments continue to legislate and regulate the right to privacy, including enacting the Data Protection Act 1998 and the General Data Protection Regulation (GDPR), which specify the manners to process identifiable information, clarify the rights of the data subject and the responsibility of data processors in protecting the data (Hoofnagle, Van Der Sloot and Borgesius, 2019). It can be seen from the interviews that these regulations are to some extent recognised by older people in the UK. However, these older people still struggle with the definition of privacy, the extent to which privacy can be disclosed, and the attribution of responsibility for privacy protection, indicating that privacy-related concepts may be superficially publicised in older people's networks, and the power to control, retrieve and freely process data is still insufficient for users compared to other stakeholders under the health technology domain (Pan, Dong and Bryan-Kinns, 2021). Older people in the UK also addressed the remaining problems in the privacy terms of health apps, including the tiny font size and the long texts that make it difficult to read. It reminds us that there might be a need to further involve users (and older users) in the design of privacy policies, in order to avoid the overly

subjective and centralised power of technology companies in the development of privacy terms. The fact that young people in the UK are less concerned about privacy than older people may be because young people see themselves as having a greater sense of control over the use of data and more trust in both government and commercial internet companies (The Royal Society, 2017). While it is not clear whether this generational trend leads to better use or more misuse of data in the UK, the same goal of the socio-technical system in both countries may always be to keep a balance between privacy protection and data sharing, as well as a balance between individual rights and collective interests, where the scrutiny of privacy entails the introduction of context-specific factors.

9.1.5 Differences in older people's participation in the development of health technologies

Older people in both China and the UK had very limited experience of participating in the development of health technologies, but there are many differences in their intentions to participate and concerns about participation. In general, Chinese older adults are conservative about technology participation and expressed a variety of concerns about participation, including few opportunities to participate, inadequate platforms, lack of inclusiveness and possible formalisation. British older people have a much more positive intention to participate and have more expectations than Chinese older people. They prefer to put themselves at the centre of participation and therefore have fewer concerns about participation and the format in which it is organised.

These differences in older people's attitudes towards participation are related to multidimensional social structure and cultural differences between the two countries. For Chinese older people, reservations about participation are partly

due to their introverted nature, as they are inclined to be humble and unassuming and to tolerate and cope with difficulties on their own rather than seeking help (Wang, et al., 2021). Consistent with considerations of privacy, Chinese older people also have a sense of inferiority regarding their abilities and agency in technology participation, while displaying trust in technology companies, technology workers and policies, as can be seen in interviews. In addition, Jia (2022) found that the decline of civil society organisations and the strict online censorship led to a decrease in critical public debates and greater official empowerment of scientific and technological experts in the discourse. In the health technology sector, this may result in the public finding it difficult to speak out about science and technology and technology companies finding it unnecessary to involve the public.

As the concepts related to public participation mostly originated in Western societies and liberal democracies, they are still in infancy within the Chinese context, and may not be well fit in China's social system in technology development. For example, there are limitations to the introduction of responsible research and innovation (RRI, see pp.56-57) in Chinese society, where technological innovation is largely about economic growth, and emphasising technological ethics and engagement may not be considered a priority at present (Zhao and Liao, 2019). It should be added, however, that there is a strong "task orientation" in the values of Chinese older people (they tend to have the belief that "if my country needs me to do this, this is the task I have to do", as evidenced by the necessity of performing the one-child policy and using the Health Code), so I am somewhat sceptical that the concerns they raise about technology participation may be based on the "task", that is, "if the concept of health technology participation ought to be introduced into Chinese

society, I have a ‘task’ to defend it, to promote its efficiency and to make new demands” – though the premise does not necessarily hold true.

Older people in the UK have relatively positive attitudes towards health technology participation. This is because, on the one hand, older people in the UK develop more needs for socialisation and learning technology (e.g., *“I’d be happy to be involved...I want to learn more things”*, p.204); on the other hand, British older people would like to actively amplify their position in society and their individual needs, attaching great weight to explore and change the world (Wang, et al., 2021). The interviews demonstrate that those who have positive attitudes towards participation tend to put themselves on an equal footing with technology workers, and openly express their opinions, which are very different from most Chinese older people. If they reap something or contribute something through participation, it is more of a full recognition of their self-worth. In addition, as data sharing is also an important way of public participation in technology (pointed out by technology workers), there may be a tension between privacy concerns and positive attitudes towards participation. Although British older people did not mention data sharing when referring to the topic of participation, one of them expressed a willingness to share health data for research purposes under legal protection (p.197), which reveals a subtle difference between data sharing and privacy breaches in their democratic nature – they recognised that data sharing is self-initiated and with consent, but privacy breaches are often passive and out of their control.

The UK seems to be more advanced than China in terms of policy development and public engagement initiatives, which provides a more comprehensive picture of technology participation for the British older people interviewed. For example, NHS England (2017) published a statutory guidance on involving the

public in healthcare governance and decision-making, setting out ten key actions to improve public participation, which suggests a number of effective patterns of public participation, calls for healthcare providers to be responsible for public participation and works to reduce health inequalities by involving marginalised groups. Such guidance may be an enlightenment for health technology participation for both the public and technology companies. However, judging from the similarly little experience of participation by older people in the UK, these policies and guidance are not necessarily well implemented, casting doubt on the fairness of decision making in health technology. Staley and Doherty (2016) found that while patient involvement in the health technology appraisal at the National Institute for Health and Care Excellence (NICE) offers a unique perspective to the committee members in the form of experiential knowledge or insight, committee members also expressed concerns about how this perspective could be incorporated into the decision-making process. In other words, the effectiveness of health technology participation in both the UK and China is still uncertain, as technology workers confirmed in interviews that some research-oriented participation may fail to be transferred to technological improvements, and there are ambiguities in the attribution of responsibilities for technology companies.

It is important to note that a comprehensive comparison of the two countries is not fully representative of all respondents, let alone all older people in the country. I have identified exceptions in both countries in my study, including Chinese older people who are very keen to voice their opinions and British older people who are adamantly resistant to participate. Therefore, the diversity of older people needs to be always taken into account by technology companies and the healthcare sectors that attempt to include older people.

9.1.6 Why do caregivers' and technology workers' attitudes not differ much between the two countries?

Whilst the interviews with caregivers and technology workers were also conducted in both China and the UK, I did not make a clear distinction between the two countries in Chapters 7 and 8, because there are very few differences. There are several possible reasons for this.

Firstly, several caregivers and technology workers have lived and worked internationally, including Chinese caregivers who have lived in the UK and the US, technology developers who have worked in both China and the UK, and innovators with collaborators in many countries around the world. Not only do they know their roles well in their own countries, but they also bring what they have seen and learnt in other countries into their perspectives. For example, for technology workers whose company targets global users, they know the background of potential users, how they think of the products, and the executive standards of technical specifications and ethics in different countries, and they have naturally incorporated these into the conversations.

Secondly, the caregivers and technology workers interviewed are relatively young and active in performing healthcare or technological work, with similarities in their lives and work. For example, caregivers may themselves be active users of some kinds of health technologies (which are not necessarily originated and produced in their country) and may be more inclined to discuss technology-related topics as "general technology users", removing the label of being a caregiver in China or the UK. To put it more simply, young people in different countries may have more in common than generational differences in their attitudes and use of technology, which is evidenced by Wilska and Pedrozo (2007) and Cruz-Cárdenas, et al. (2019).

In addition, most of the caregivers and technology workers grew up in the digital age, which establishes a strong cultural fluidity. China's rapid development after the reform and opening up in the late 1970s has allowed current young and middle-aged people to be surrounded by technological innovation in the same way as those in the UK, giving rise to similar ideas of "placing technology in the premier position" (will be further explained in section 9.2). It is also possible that with the increasing awareness of data privacy in China and the decreasing privacy concerns over generations in the UK, young people in the two countries will have converging conceptions of data privacy (Wang and Yu, 2015; The Royal Society, 2017).

9.1.7 The comparison of older people's relationships with caregivers and technology workers

Despite the similarities of the perceptions and roles of caregivers and technology workers in the two countries, there are slight differences in their relationships with older people and their responses to the ageing and technology-related policies.

The interviews show that Chinese caregivers (especially family members) undertake more caring responsibilities for older people and intervene more in older people's use of health technologies than British caregivers. For example, Chinese caregivers are more likely to purchase health technology for older people and teach them how to use it; Chinese older people are more resistant to technology for ageing in place because of more caregiving expectations from family carers. The duty of care is closely linked to filial piety in Confucianism[26],

[26] Or "Xiao" in Chinese, refers to a respectful attitude towards parents and ancestors through caregiving, financial support, living arrangements, etc.

which has a deep and continuing influence in Chinese society, while older people in the UK seem to be unlikely to have filial expectations (Laidlaw, et al., 2010). However, in recent years, there may be erosion in the adherence to filial piety. With the one-child policy and young people moving away from their hometowns to big cities, older people are becoming independent and are less likely to be cared for; and children have begun to shed the caregiving responsibilities and may even devalue older people's need to use healthcare resources (Cheng and Chan, 2006; Zou, Fitzgerald and Nie, 2020). This trend may further reverse the relationship between older people and caregivers in the future.

Technology workers found it easier to collect health data in China than in the UK. They indicated that in China, the loose regulation of data by governments and technology companies allows them to have less impediment in technology design and launch. This situation is a boon for achieving large-scale population health management. For example, COVID-19 outbreaks can be quickly controlled with a wide coverage of the Health Code, with a "confluent perception of states and algorithms" (Liu, 2022). However, as it is hard to identify the flow of data in technological networks, such data collection may still be subject to constant questioning. British older people's greater concern about data privacy can make it more challenging for technology workers to access health data, and technology workers suggested that they need to write and submit more ethical reports to demonstrate that their technology products comply with regulatory requirements. Therefore, there seems to be more tension between technology users, developers and policies in the UK than in China.

9.2 Differences in groups: how do older people, caregivers and technology workers consider health technology and the relationship between older people and health technology?

Unlike many other studies focusing on older people's technology use that only recruited older people as participants, my study involves three groups of interviewees – older adults, caregivers and technology workers – to synthesise a comprehensive picture of older people's technology acceptance and participation. The empirical chapters showcased that the three groups agreed on some standpoints but also had many different perceptions about older people's identity, the positioning of health technology, and the relationship between older people and health technology. This section will compare the specific similarities and disparities between these three perspectives, explain how they are constructed, and discuss the implications of the similarities and disparities.

9.2.1 Diversity in the construction of older people's image

Some studies mentioned in the literature review present older people as single and flat "vulnerable" figures due to declining health (e.g., Sponselee, et al., 2007). This perception does exist in the group of British older people in my study, as declining health may trigger more need for health technology, but it is not a dominant view. My study instead establishes the diversity of older people's image and shows that while older people try to stabilise their image, health technology can disrupt this stability and caregivers and technology workers can challenge this stability by establishing or hypothesising relatively negative or passive discourses.

From the findings of older people, we can summarise that older people tend to perceive themselves as and want themselves to be “calm” and “stable” and have a “reserved” attitude towards their lives, such as being content with the status quo and attempting to maintain and recover physically and psychologically in a variety of ways (trying to maintain good health, to maintain self-identity through the establishment of social relationships and to maintain a sense of control in the wake of environmental changes). This is consistent with the findings of Burr, et al. (2021) that older adults may be better than younger adults at regulating emotions and resisting desires; and consistent with socioemotional selectivity theory, which indicates that older people tend to choose social partners and social behaviours that make them feel comfortable, rather than to engage in relationships that may be meaningless, risky and future-oriented (Carstensen, 1995). This is related to older people’s past experiences (e.g., resistance to unstable lives and emotions in turbulent times) and the current social environment (which endows older people with a better political and economic basis for stable lives), which makes them oriented towards the present and try to maximise well-being every day (Perry, 2020). Older people’s perceptions of themselves essentially align with the technological identities they try to maintain, that is, a stable technology user or non-user identity (but not always practically achievable due to technical problems or external influences), potentially contributing to the ego waves and the periods of adaptation that occur when embracing new technologies.

The emergence of health technologies has indeed created contradictions in older people’s perceived self-image. Research shows that a person’s self-esteem peaks as they enter old age (60 years) and then decreases with age (Orth, Trzesniewski and Robins, 2020). It can be seen from my research that some older people engender active maintenance of self-esteem when

passively accepting health technology, for instance by countering the stigmatisation of health technology and rejecting the mobile aids by health technology that would create dependency. However, they also identified the inability to maintain self-esteem in the co-existence of ageing and technology, which left them reluctant to give up their insistence on independent use of technology and privacy protection. Additionally, interviews show that there is ambivalence about older people's comfort with expressing themselves autonomously in different contexts. For example, having no difficulty communicating with people offline is one of the reasons for older people to decline online healthcare but some of them refuse participation in health technology because of possible communication difficulties. The ambivalence of older people's self-image reinforces the importance of the technological contexts intertwined with their identities and extends Jasanoff's (2004) notion of the co-production of technology and identity, as not only are identities fixed or redefined as technology evolves but when there is a change in the technological contexts or personal situations, older people correspondingly change their self-image and identity that interact with (but does not necessarily match) the contexts.

There are similarities between the image of older people in caregivers' perspectives and older people's self-perceptions, as caregivers talked about living with older people over time. Caregivers also spotted older people's pursuit of a stable life (e.g., keeping frugal and a regular pace of life), but they described this in relatively negative terms, emphasising the discrepancies between older people's views and theirs, and reflecting an intense sense of disapproval. Caregivers also refuted the emotional stability of older people by depicting their stubbornness and extreme attitudes towards health issues. When it comes to the interaction of older people with technology, the image of older people as

“vulnerable” is more evident from the caregivers’ perspective, especially by their description of older people’s need for help, guardianship and coordination; yet they did not abandon the account of older people’s autonomy. Generally, the caregivers’ perspective is critical, which may be related to their position, as in their view, social caring responsibilities and caring work can potentially empower them to take the high ground in criticising those they take care of.

Technology workers’ understandings of older people are basically from their assumptions (e.g., older people’s rejection of health technology is because of a lack of knowledge) and the shape of older people by health technology (rather than actively presented by older people). Compared to older people and caregivers, technology workers more clearly emphasised the passivity of older people when interacting with technology. For example, they primarily set older people as passive clients of health technology by analysing the benefits of health technology for them and the difficulties older people might have in using it, rather than how older people can shape the technology. Unlike the other two groups who had a detailed understanding of the daily lives of older people, technology workers did not fully develop a synopsis of older people as potential users of health technology (just as in a screenplay, there should be character biographies, which include the character’s appearance, personality traits, family background, social relationships, etc., but they may be missing in the scripts created by technology workers for older people’s use of health technology). Some technology workers confessed to having difficulty reaching and communicating with older people, which could be a reason for the lack of image depictions of older people. In addition, interviews also indicated that there is a hegemonic tendency, goals of profitability, and task-oriented work patterns in technology companies, which may all contribute to the blurring image and the perceived passivity of older people.

As can be seen from the comparison above, older people and caregivers consider more about the tangible lives of older people as similar, but their differences in life experiences and roles produce different perceptions of lifestyles and technological behaviours. Technology workers are almost completely unaware of older people's practical lives (their views on older people's acceptance and participation in technology will be discussed later), and their perceptions of older people as passive clients of technology hint at a lack of communication between them in technology systems. We cannot blame the three groups for the one-sidedness of their respective positions, as they also have specialisation in their roles – the specialisation of older people as having more life experience and diversified constructions of self-image, the specialisation of caregivers at making image projection as paradigms in living with older people, and the specialisation of technology workers in the position of manufacturing and promoting health technology. The specialised construction of older people's diverse images reflects the problem of treating older people exclusively as a "vulnerable group". On the one hand, such a view negates the older people's active stabilisation and adjustment of their identities; on the other hand, it ignores the possible positional bias of the subjects who construct the image of the "vulnerable group". Combining older people's own perceptions and other stakeholders' opinions can help sketch a relatively holistic personal and technological image of older people and grasp the alignment or bias of different positions (Peek, et al., 2016).

9.2.2 Generational differences in the positionality of technology

Generation gaps are commonly thought to exist in the sense that older and younger people can have differences in perceptions and values due to differences in the situation of the world at the time they grew up, which is evident

in the family context and may widen in the digital society (Aggarwal et al., 2017). In my research, the generational differences do not only stem from the difference in the degree of engagement and intergrowth with technology between digital natives and digital immigrants but also stack up to the divergent positioning of technology among the three groups of interviewees. I would like to propose the concept of “technology in the premier position or posterior position” to explain these differences. Caregivers and technology workers as young or middle-aged people place technology in the premier position, presupposing the inevitability of its use, the interactions with it in their lives and the advantages of it to conceive older people’s antagonism with technology; in contrast, older people put technology in the posterior position, and think about the challenges and changes that technology will bring to them based on the stability of their lives. The difference of placing technology in the premier or posterior position resulted in contradictory feedback from the three groups of interviewees and some lack of understanding of each other.

Chapter 7 shows that most caregivers had positive attitudes towards health technology and summarised plenty of the advantages of the technology. From their own perspectives, health technologies are convenient, useful and fun. They also concerned about privacy and the ethical issues of ageing with technology and challenge technology workers and administrative departments in this regard, which demonstrates a clear commitment to the protection of conflicting norms in social circles in the context of the new era (Blank, Bolsover and Dubois, 2014), social awareness of the rights of the individuals, and a determination to the responsible use of digital technology and the protection of privacy as a “common, public and collective” value (Bryce and Klang, 2009).

Technology workers have a more optimistic view of health technology than caregivers, based on their social and work positions. Interviews show that they have a good knowledge of the mechanics of how health technology works in detail and process, such as how to implement a particular feature and how to promote the technology. They developed the logic of the inevitability of healthcare digitalisation and deliberations on the digital divide in their work routines, hoping more people (not solely older people) to become users of health technologies and respond to the trend of healthcare digitalisation.

These views of caregivers and technology workers may have been influenced by technological determinism to some extent because considering the digitalisation of healthcare as an inevitable trend may overlook the social conditions that construct it (Lupton, 2014). Caregivers and technology workers emphasise the premier position of technology with similarities, which may be because they grew up in an era of rapid technological advancement and have a subjective feeling of not being able to resist it, which results in an exaggeration of the significance of technology (Selwyn, 2009). However, they also have a certain awareness of the role of human society in the development of technology, as they believe that people (basically young people) can act as the dominant agents of technology to select, criticise and arrange it. In other words, when they place the technology in the premier position, the human society is in the secondary position – human society can have powerful effects on the technology, but they are not decisive.

Older people's perceptions of health technology differ significantly from those of caregivers and technology workers. Most older people were unclear about the term "health technology" (or even "technology") as a collection of concepts and cautiously asked whether an item belongs to the range of "health

technology". However, caregivers and technology workers could both give a wide range of examples at the same time as I introduced the concept. For older adults, placing technology on the back burner is tied to their past life experiences, as can be seen in the interviews that because they were able to stay healthy without the presence of health technologies in their past lives, it was fine to not use it or lose it; and that because learning about new technologies such as cars and computers in their past lives was through specific classes, a similar kind of instruction was also needed for learning about health technologies.

Older people who place technology in the posterior position have many ambivalent attitudes. They likewise have positive attitudes towards health technology similar to the other two groups of interviewees, because they do recognise some desirability of health technologies, such as digital health devices to raise health awareness and set reminders and smartwatches to regulate health management. However, their positive attitudes towards health technologies do not necessarily equate to positive evaluations of the technology but are sometimes rather shaped by the expectations and domestication of other stakeholders. For example, by showing positive attitudes they may try to reassure caregivers who (help) purchase the technology devices (appreciating the care rather than appreciating the technology); to give health technology developers a sense of good reception of health technology; and to generate a public response to the governmental departments and healthcare organisations that make technology-related decisions (e.g., "*We are actively responding to the national policies"*, p.121). Wang (2023, p.202) discovered that many older people share the trait of "self-sacrifice for family and country" (and sometimes indulge in self-applauding), which was well exemplified in the adoption of the Health Code by Chinese older people and the case of British older people

getting the Fitbit free of charge, as “this technology is good because I am being expected to use it in a good way”.

Very different from caregivers and technology workers, older people’s negative attitudes towards health technology are quite evident. The main criticisms of older people are manifested in the difficulty of operating the technology, ageism and stigmatisation of health technology, concerns about privacy breaches and social inequalities brought by the technology. These criticisms are not just about the technology itself but about the whole social system associated with the technology, or to say, “it is a social process more than a technical matter” (Peek, et al., 2016). Negative attitudes emerge from questions about the infrastructure and accessories required to use the technology (e.g., WIFI, smartphones, manuals), the people who can provide technological aids, the developers and operators of the technology (regarding advertising and after-sale services), and the social policies about the technology (e.g., macro-adjustment of price, laws of data privacy). This hints at a common misconception in studies applying technology acceptance models that improving certain aspects of technology helps increase technology adoption (e.g., Li, et al., 2019), and prompts us to instead look at wider socio-technical networks, such as the institutionalisation of technology use and healthcare coordination (Ienca, et al., 2021).

We can see that when older people place technology in a secondary position, it is the individual interest and the collective community that are in the premier position. However, their views do not fall into the concept of “social shaping of technology” in the traditional sense, because technology in the posterior position is sometimes dispensable. In this case, older people’s acceptance of technology is not an attempt to shift technology from the back to the front, but

rather to keep technology “existing” in the posterior position, then it becomes especially essential to focus on whatever things are in the premier position.

9.2.3 Social inequalities associated with health technology acceptance

Even before the existence of emerging health technologies, inequalities in the field of healthcare were already apparent between older people and other age groups, as older people had less access to appropriate, affordable and quality healthcare (United Nations, 2018). The invention and popularisation of emerging health technologies have further exacerbated these inequalities, which are revealed by the disparities in the perceptions of the three groups of respondents about technology use by older people (or by themselves).

The disparities and inequalities are first reflected within the older population. The interviews identify that older people’s use of health technology is stratified by health status, education and social status, and related to their attitudes towards caregivers. It is generally recognised that declining health may lead to negative technology use (Nayak, Priest and White, 2010), which is also indicated by the statement in my research that poor eyesight and dexterity can make it hard to operate technology (pp.120-121); the exception of health technology, however, is that declining health status may generate more significant demands for health technology and relatively positive attitudes towards it, aligning with Li, et al. (2019). Comparisons between the use of the Health Code and the paper certificate reveal a chain of contempt regarding educational attainment and technological literacy, as older people who are relatively younger, better educated and perceive themselves as having a superior social status will look down upon the paper certificate and those who use it. Older people’s attitudes towards caregivers can be related to attitudes towards health technology for ageing in place, as older people who prefer and

trust human caregivers would dislike ageing with technology, whereas older people who do not trust human caregivers or who do not want their children to be overburdened with caring responsibility would appreciate the benefits of health technology for ageing in place. These differences complement the personal factors affecting older people's technology acceptance in the literature review and in these correlations, we can detect a social expectation of older people with different conditions, which also corresponds to "making identities" as an instrument of the co-production of technology and society Jasanoff (2004, p.39). An illustration is that older people with higher levels of education and social status (representing a privileged group) are expected to behave like a tech-savvy person and "silver surfer" (Olsson and Viscovi, 2020), corroborated by the fact that the worker in the neighbourhood community was reluctant to give them paper certificates (pp.127-128).

The comparison of caregivers' comments on their technology acceptance and older people's technology acceptance also reveals inequalities between the two groups. When caregivers consider the use of health technology by older adults, some of the advantages they cite are invalid and even have counterproductive effects on older people. For instance, it is not as easy for older people to use online healthcare platforms as they are (inequalities in using technology); they find it hard to understand the encroachment of online healthcare on offline services and the ageism of health technology complained about by older people (inequalities created by technology). It can be deduced that during caregivers' time living with older people, their perceptions of older people's technology use are often observational rather than empathetic. Observable technology limitations may have attracted much attention, and caregivers have devoted themselves to the roles of introducers, trainers and guardians in an attempt to address these limitations. However, the issues that are unobservable require

others to think more fully through older people's roles, as well as further and more rigorous scrutiny at the societal level, although it may still be difficult to eliminate these gaps in understanding through scrutiny (Woodcock, et al., 2020).

Technology workers know little about the actual relationship between health technology and older adults. They target older people as singularly as clients and older people are often even not the primary target for technology promotion, so they have few opportunities to gain further and all-round insight into what older people think about health technology. They take data privacy issues to laws and governance but fail to think about the crisis of data breaches from users' point of view. The lack of understanding is on the one hand due to that they did not need to be responsible for other arrangements than their own share of the work, according to their statement. On the other hand, this situation is also related to the objectives of the technology companies or organisations as a whole, or even the orientation of social policies. Companies and organisations under the market-oriented system often aim at profitability and tend to perceive older people as an irrelevant user group because of false stereotypes about older people's capability to assess technology (Compagna and Kohlbacher, 2015). When data-driven technologies are committed to government decisions, the least powerful groups are rarely considered, leading to discrimination and conflict (Smallman, 2022). Technology workers, following the companies' arrangements and social policies, automatically allow the launch of technology to enhance inequality, driven by interests, policies and a lack of understanding of users. Moore and Woodcock (2021) introduce the control and deep exploitation of workers by algorithms when technology is used for labour management. Likewise, my findings show that in the field of health technology, big and unportable smartphones, imbalanced medical resources caused by

telemedicine, and unaccommodating travel restrictions caused by the Health Code are all tangible illustrations of the inequalities.

Van Dijk (2005) summarised a model of resources and appropriation of digital technologies, arguing that differences in personal characteristics (age as an important component, as well as gender, ethnicity, health, etc.) and positional characteristics (e.g., labour, education, household) produce competitions and inequalities in the distribution of resources, and are manifested in four stages of technology appropriation: motivational, material, skills, and usage access. In my research, by comparing the positions of the three groups of interviewees, we can identify how older people's acceptance of health technology corresponds to these four stages and the associated inequalities, including

1) Motivational: Inability to connect (or difficulty in connecting) and avoidance of use (irrelevance or incompatibility) because of the unavailability of material and psychological resources, while younger people have more motivational proximity to technology.
2) Material: Concerns about the price of technology and technological space, which may be related to a lack of economic discretion and the right to choose autonomously household possessions.
3) Skills: Inadequate skills in the use of health technologies, as evidenced by perceptions that the technology is difficult to operate and information about the technology is confusing, pointing to fewer opportunities for skills acquisition and trial and error for older people than young people.
4) Usage access: Low frequency and effectiveness of use, and lack of development of advanced functions of technology, which may be caused by differences in socio-cultural resources, and older people may need more effort than younger people to adapt to the world with rapid technological

development.

By outlining these phenomena, I am not suggesting that not using health technology is an inaccuracy and backwardness, but rather that we need to realise the lack of choice that older people face with these unequal dilemmas. It can be recognised that technology, the gap in using technology, and the lack of choice can all lead to further marginalisation and even social exclusion for older people. Younger people are relatively optimistic in the light of skewed technological resources because they have more advantages or even hegemony in the knowledge and use of technology (Kim and Choudhury, 2020). However, Outila and Kiuru (2021) remind us that "optimistic technology discourse is part of a broader development" and the digitalisation of healthcare may be accompanied by an actual increase in healthcare responsibilities for various actors. I will further discuss the agency and the construction of responsibility of different actors in the health technology system in section 9.4.

9.2.4 The empowering paradox of health technology participation

Van Dijk (2005) also argues that inequalities in the use of technology by different groups can lead to differences in social participation, which is most directly reflected in the participation in the development of technology. Older people, caregivers and technology workers have varied attitudes towards technology participation, the most obvious of which is the empowering paradox about it.

Caregivers endorse participation as an empowerment in interviews and believe that they can play an instrumental role in facilitating and guiding older people's technology participation in a variety of identities. In their view, older people have a low level of experience, awareness and motivation to participate, so they feel

responsible for bridging the gap between technology workers and older people by acting as organisers and mediators; but conversely, caregivers' representation of older people's participation may in some ways undermine older people's autonomy, analogised to clinician's substitution of the autonomy of patients in making medical decisions (Sherwin and Winsby, 2011). All three roles that caregivers play in older people's participation are essentially moderating roles. Caregivers subconsciously see themselves as more active technology users and owners than older people but may overlook the dominant role that older people can also play in participation.

Technology workers' perceptions of older people's participation are somewhat ambivalent. While they recognise the need for older people to participate, in practice they exclude older people for a variety of reasons. In presenting their views, technology workers are almost exclusively speaking from the perspective of their company and themselves (whether to involve older people, how to get in touch with older people and how older people's participation can benefit the technology) and rarely consider older people's ability and willingness to participate. It seems to be taken for granted that if their companies or research institutes provide opportunities for older people to participate and establish a systematic framework for participation (as challenging as that may be), they will reap the benefits of good interactions with older people. However, there is a risk that older people's participation under this model can be templated and formalised, with a crisis of older people responding to pre-set sessions due to their position as passive participants, and that their true wishes may instead not always be valued (Fischer, Peine and Östlund, 2020). This form of participation has similarities to agenda setting, whereby the communicator preemptively shapes the opinions of participants through the arrangement of information (McCombs and Shaw, 1972).

Older people's perceptions of participation differ from both caregivers' empowerment narratives and technology workers' responses of "necessary with risk of formalised arrangements". According to the interviews, older people with strong intentions to participate construct a relatively idealised picture of participation, in which they are able to actively make suggestions and learn about the technology, and technology workers would take their suggestions seriously and make changes. We can see in this picture that older people's image of being "old" is not visible, and they think of themselves more as pure, age-neutral users and participants of health technology and look forward to communicating with technology workers on an equal footing. This may be due to the complementation of self-abasement and high self-esteem as being older people, or it may be partly an analogy between technological participation and other social, political and cultural participation, with an attempt to transfer attitudes from the known to the new and uncharted realm (p.163). Older people with negative attitudes towards participation tend to emphasise their identity as "older people" and their incompetence with technology, creating a natural distance from younger technology workers. Older people who have concerns about participation pointed out the unknown outcomes and possible inequalities in participation as excluding socially disadvantaged groups, which is also mentioned by Merkel and Kucharski (2019). Such negative attitudes can be categorised into "unwilling" and "unnecessary". Those who are unwilling to participate cite personal reasons for that, such as poor health and eloquence, whereas those who believe it is unnecessary for older people to participate express their views by belittling themselves and the whole older people's community, or even by disapproving of other older people's participation. This is related to their negative attitudes towards active ageing and stems from their assumption that there is a holistic dissonance between older people and health

technology participation, as Fischer, Peine and Östlund (2020) found a majority of studies about older user's involvement in technology design portrayed them in terms of age-related deficiencies.

Therefore, I suggest that older people's inequalities in health technology participation may be largely captured in the subordination of discursive priorities, as they are not a prioritised group for technology participation in the eyes of technology workers and are a passive group for technology participation in the eyes of caregivers. Powerful interest groups have long been the real authorities in deliberative spaces, rendering seemingly public consultations closed and inward-looking (Jasanoff, 2016, pp.239-242). In my research, health technology companies and policymakers assume the power subjectivity of participation, and they may not authorise deliberation well enough for the participation of older people, leading to the result that stakeholders have very different understandings of technology participation. Interestingly, according to interviews, many older people do not seem to regard technology participation as empowerment (considering it irrelevant, or see it as a deprivation of personal freedom, time and routines of life, e.g., *"It's just a waste of my time"*, p.210), which demonstrates older people's distinctive interpretation of their roles and even the democratic nature of the society. Abbott, Fisk and Forward (2000) found that there are many misconceptions between older people and staff in charge of participation. When older people consider whether to participate, it is often based on a sense of self-reasoning rather than democratic openness. Some of their findings are similar to my research, including that older adults assess social participation for the avoidance of loneliness and depression, confirmation of self-usefulness, spatial comfort with participation (being able to distance themselves from other parts of society that are unsettling), and comfort with making suggestions and complaining. My research adds to this older

people's preference for paid participation and the benefits of technological improvements for themselves. It can be inferred that few of these concerns are pertinent to democratic power. Technology workers, staff in charge of participation and the wider social community may perceive "getting people involved" as a form of empowerment (albeit not necessarily done well), but due to the lack of transparency in the technological space, it is difficult for older people to ascertain exactly what is happening in the technology and where they fit into the technological structure, which may be the reasons for their avoidance of the democratic nature of "getting involved". As non-transparent participation can lead to skewed interest, there is a need to mitigate inequality and clarify the attribution of responsibilities related to technological participation (Merkel and Kucharski, 2019).

9.3 Rethinking ageing: how are different concepts of ageing co-produced with emerging health technology?

Preliminary references to definitions of "old age" by other researchers and official documents in China and the UK have been given in the chapters of literature review and methodology, which describe its statistical and social attributes. I have published a systematic literature review on older people's attitudes towards technology, in which I also found that much of the literature did not strictly define the terms "older people" and "ageing" and I discussed how older people's identities are socially and culturally constructed, as well as co-produced with the acceptance of technology (Zhang, 2023). The third part of the discussion will further develop this point in light of empirical data, by proposing how the six concepts associated with ageing (longevity, healthy ageing, successful ageing, active ageing, negative ageing and psychological

ageing) intersect, mutually reinforce and limit the acceptance of and participation in emerging health technologies.

9.3.1 From longevity to healthy ageing

The desire for longevity has existed since ancient times and has been regarded in diverse cultures and religions as the ideal scenario. The average life expectancy in a country or region symbolises its socioeconomic background, as a more developed country or region will have a more advanced level of science and technology (especially medical science), in order to address the diseases and functional deterioration that may occur in the ageing process and to maintain a longer life (Bilas, Franc and Bošnjak, 2014).

In recent decades, the pursuit of longevity has not only referred to the accumulation of age. Rather than needing to be bedridden for long periods to sustain life and suffering from chronic illnesses in later life, older people are now striving for "healthy ageing" – to "maintain the functional ability that enables well-being in older age" (World Health Organization, 2015). In 2020, the United Nations endorsed a proposal to proclaim 2021-2030 "the Decade of Healthy Ageing" and invited collaboration from all sectors, including governments, social institutions and academia to safeguard the healthy lives of older people (United Nations, 2020). In my research, the visions of older people interviewed in both countries are largely aligned with the proposal, as they repeatedly mentioned their desire to stay healthy by developing habits of exercise and self-care and developing a clear sense of their health through regular check-ups. It can be observed there that most older people accept the natural process of ageing, and therefore "healthy" does not mean being completely free from illness and pain and being able to move around as freely as they did in the past. They allow themselves to have "age-related conditions" (typically vision loss,

high blood pressure and osteoporosis), as long as the conditions remain manageable and do not render them as vulnerable by needing to be cared for.

The transition from the pursuit of longevity to healthy ageing reflects the convergence of older people to modern science and is also related to the overall context of society. The health habits of current older people are mostly guided by scientific evidence (e.g., focusing on data indicators during check-ups, referring to self-care recommendations given by experts). Older people, while passively accepting the process of ageing, empower themselves with subjective initiatives to make changes, rather than hoping to achieve longevity by resorting to external occult forces, or adhering to fatalism, which holds that human longevity and destiny are pre-determined and not subject to the will (Maercker, et al., 2019). In addition, the development of society has given more older people the opportunity and power to pursue “healthy ageing”, as many of the health behaviours of older people need to be based on a certain level of socioeconomic capability and policy support (Beard, et al., 2016). For example, sophisticated instruments are required for medical check-ups and the national government provides insurance and welfare for healthcare (e.g., free healthcare services provided by the NHS in the UK). Although the quest for longevity to healthy ageing is a progressive change, the two are not contradictory, and belief in scientific health habits and spiritual powers (or alternative medicines) sometimes coexist, as they are both essentially a form of “maintenance” of life and well-being (Sointu, 2006).

Chapters 3, 5 and 6 identified clear examples of health technologies facilitating healthy ageing, as one part of co-production. Technology workers believed that health technology helps older people manage their health, and older people confirmed its effectiveness in health apps reviews and interviews, with evidence

of reassurance from normal results produced by health devices or feeling the need to take action because of abnormal results, obtaining more knowledge of diet and sleep through the use of smartwatches, and keeping a good mood through the use of recreational health technology (pp.136-137, 173-174, 201). In this human-technology connection, the human behavioural practices and material aspects of technology are inseparable (Frennert, et al., 2022). The materiality of health technology refers to that these health behaviours are entirely dependent on the presence of health technology, and health technology leads to more efficient healthcare when correctly designed and used (Law, 2012; Frennert, et al., 2022). The agency and the proactive role of health technology will also be further discussed in section 9.4.

Health technology has also somewhat altered the definition of “healthy ageing”, shifting it from older people’s own ideal to a broader, shared definition provided by technology and stakeholders of technology. Firstly, it transforms “healthy ageing” from an autonomous physical sensation into a quantitative standard and generates data for older people to compare with the standard and other people, which cultivates self-disciplinary mentalities and compel norm-conforming behaviour (Sanders, 2017). The right to self-control over the body turns into an action to make decisions from data and sometimes the decisions are even made by technology (e.g. “*I used to walk until I felt tired, but now I stop walking when I reach 10,000 steps”,* p.141). Secondly, it instrumentalised “healthy ageing” by offering tools to assist older people in almost every step of their activities. Health technology can even become part of the “natural person” and the body is digitalised and reconfigured due to the routineness of health management (Lupton, 2013). Thirdly, the environment of “healthy ageing” is tilted towards the “home”, as digital health devices, home health monitors and smartwatches all highlight the notion of the home and personal space and are

designed to detach from hospitals and other “health-specialised” environments. It redefines the notion of home as a private space and creates an environment in which health becomes an active theme in personal life (Oudshoorn, 2012). In addition, the relatively high price of some health technologies begins to link “healthy ageing” to “consumption”, which may inadvertently raise the economic threshold of “healthy ageing”.

Inversely, older people’s pursuit of longevity and healthy ageing has engendered a demand for health technology and further shaped health technology, as another aspect of co-production. In interviews, it was found that although older people rarely actively conceptualise and articulate the need for health technology unless there are diseases to be controlled, the prevalence of the pursuit of healthy ageing can lead to sustaining the demand after a trial, or even reselect a new, more accurate and better-adapted technology once the existing one is unavailable (pp.135-136). In this process, they build up a diverse range of usage patterns, including insisting on using only the basic health functions and rejecting the development of the full functionality (e.g., using pen and paper to record health data rather than uploading them via the Internet or Bluetooth, p.133); use the technology in strict compliance with brochures and instructions, or stop using it when finding it did not match the anticipated health goals. This can shape the technology by requiring technology workers to simplify its functionality, improve user instructions, or rethink its purpose. The practices of older people complete the technological closed loop from technology workers’ prescribed scripting (their expectations of the ways people use the technology) to tailored interpretation and use. Woolgar (1990) describes how users shape technology through flexible interpretation in “Configuring the user: the case of usability trials”, and I would like to build on this by depicting the relationship between the technology and the user as a gear

– both of them evolve and rotate to partially engage and partially disengage, resulting in run-in and wear, and where the parts that engage and disengage are constantly changing.

The wear of the gear refers to the limitations of health technology on older people's healthy ageing and the constraints that older people's health goals place on health technology. Some of the counterproductive effects of health technology on older people's health are evident in the findings, such as quantifying sleep and diet sometimes making them anxious and not being able to operate online healthcare systems makes it even harder to visit hospitals and clinics. Similarly, older people's idea that do not want to be kidnapped by too much health data and the vision of health technology being able to cure diseases are also cut off from, or not met by existing health technology. In the case that technology can be chosen autonomously, older people can forgo their use anytime; however, in the case of socially deployed and mandatory health technologies (e.g., the Health Code, sensors installed in care homes), older people have to wait for the technology to be updated or passively compromise to the social environment that has been constructed with the technology. The other two groups of people involved in the interviews, the caregivers and technology workers, may play a crucial role in this, which will be stated specifically in section 9.4.

9.3.2 The idea of successful ageing and health technology

The concept of "successful ageing" began to attract people's attention in the 1980s. Rowe and Kahn (1987) proposed a preliminary version of "successful ageing" based on physiological and psychosocial factors. They further modelled its definition in 1997, as I provided in the literature review, to involve three factors: avoiding disease and disability, high cognitive and physical

function, and engagement with life (Rowe and Kahn, 1997). It adds to “healthy ageing” with the demands of social functioning and life satisfaction (Depp and Jeste, 2006).

Some of older people’s views on ageing in interviews are in line with the concept of “successful ageing”. The first is to have sufficient financial capability, which includes previous wealth accumulation, satisfactory pensions and social benefits (usually depending on the pre-retirement job and the development of social policies), possible extra income, and financial support from children. The second is to have reliable social partners, such as old friendships for older people in China and new social relationships for older people in the UK (pp.114, 169-170). The third is to develop a sense of belonging in the living environment, which means preserving their stable living conditions or enjoying a new life with a positive attitude following relocation, especially after the loss of family members (p.168). The fourth is to have dependable family members. On the one hand, older people want their children to do well and to be the ones on whom they can rely (for Chinese people this is a kind of “face” or prestige that will lead to judgement by others (Zhang, 2016)). On the other hand, they also want to remain independent and not completely dependent on their children (or caregivers) or become a burden to them. Furthermore, they still wish to have the ability to “be relied on”, for example, by being able to raise their grandchildren (pp.168-169). The view of “ageing” as “growing up”, which is held by some older people interviewed, may better encapsulate their idea of “successful ageing”, that is, ageing is not a passive deterioration, but rather a process of “successfully” maintaining the ability to keep up with the world.

Older people’s quest for successful ageing beyond healthy ageing showcases multidimensional indicators about the quality of life in old age and the plurality

of their spiritual world. The notion of successful ageing expands the demand from the protection of the individual to the freedom in a small immediate environment, involving the maintenance of self-esteem in the environment and perception of continuing meaning in life (Borglin, Edberg and Hallberg, 2005). It is not only about family and friends and the need for constant interactions with them, but also to some extent about the need for better social policies.

The interviews show that health technology plays a positive role in older people's successful ageing in various aspects. The positive effect of the high price and complexity of health technology is that some older people use them as a manifestation of economic power and wisdom (for example by saying that they are "not poor" and "not backward") and to demonstrate self-confidence and self-esteem in their use. The social role of exercise data in health apps and smartwatches allows older people to develop conversations about health in their social networks and is a solidification of social relationships, where active users of health technology are empowered. Relationships between older people and their family members are sometimes positively altered by the interactions in its purchase and use (e.g., "*bought another for them... they were really appreciative*", p.229). Some people mentioned the inauspicious connotation of the hospital and the cultural habit of avoiding visiting hospitals. If health technology could help older people with the habit, it would protect the image of older people's health and contribute to successful ageing.

Moreover, the mandatory use of the Health Code in China reflects the materialisation of morality by health technology. The materialisation of morality is a concept raised by Verbeek (2006). He argued that in comparison to the concepts of scripting by technology workers and the flexibility of users in "descriptive settings", the materialisation of morality is the regulation and

constraint of user behaviour by technology in a “normative setting” (Verbeek, 2006). Although older people in interviews did not specifically refer to the preservation of self-image by acting morally, the importance of naturally integrating the use of the Health Code into responsible ageing was well implied by older people under the socialist context of China and based on the older generation’s upbringing at the expense of individualism and the espousal of the collective good.

Conversely, health technology also poses some limitations to the successful ageing of older adults, with some of the factors deriving from the opposite side of the positive effects. For instance, some older people complained that the health technology is too expensive, then the purchase of the product can be a hazard to successful ageing when they are in a tight financial situation. Ageing-in-place technology can be an “alien” intrusion into older people’s normal lives and a threat to their sense of belonging in their environment. Most older people require the stage of “learning” technology, which evidences that health technology may not integrate naturally into older people’s lives, but needs to be buffered by the intervention of children and other caregivers. Older people also mentioned a possible dependence on health technology, which is opposed to the independence element of successful ageing.

The concept of successful ageing has shaped health technology and the technology system in another way as co-production. For health technology itself, older people pointed out issues of ageism in user interfaces and the stigma associated with health technologies. These concerns require adjustments in more appropriate font sizes, simpler operating procedures, unobtrusive and aesthetically pleasing designs, as well as shifts in the social perceptions of health technologies. A scoping review shows that there is a growing interest in

user-centred design and technology developers begin to adapt technology products to better meet the needs of older people (Matthew-Maich, et al., 2016). Additionally, older people's interest in social interactions have turned the health apps into social tools. For the socio-technical systems, older people prompted paper certificates as an alternative to the Health Code. On the one hand, older people demonstrate their right to speech by proposing the rejection of digital codes and the use of paper certificates (Yu, 2024); on the other hand, some of them decline paper certificates and draw the attention of the designers and policymakers to its potentially stigmatising connotations. Another example of older people shaping the socio-technical systems is the reconciliation of telemedicine and offline healthcare. Healthcare systems have had to focus on older people's needs for in-person appointments in the context of the digitalisation of healthcare and consider having more on-site receptions, service staff, and assistants who can help older people access online healthcare on an equal footing (Karliner, 2022).

Successful ageing has also shaped health technology counterproductively, which can act as a straitjacket imposing more stringent rules, and it often results from the sandwiching of two perspectives. The price of health technology is simultaneously a reflection and a hazard to economic power due to income disparities, and this requires technology workers and policymakers to give greater consideration to the cost of health technology (Czaja, et al., 2013) – for technology companies, how to appropriately lower the price of their products while remaining commercial and profitable in order to achieve the corporate goal of making more older people accept the technology; for government departments, whether and how the price of health technology should be regulated by the government, and what indicators they need to refer to when making the arrangements. Interviews show that health technology's protection

of older people and older people's independence are often not met at the same time, as well as older people's needs for technology and their preferences for human caregivers. Therefore, technology companies need to consider the extent to which health technology is allowed to function and occupy older people's living spaces, and the extent to which data is collected and privacy is protected. These issues cannot be solved by technology companies alone, but rather call for better and more practical understandings of older people through various means, and further improvement of the relevant legal system. Overall, based on older people's expectations of successful ageing, those involved in different sectors of health technology need to consider how to provide more convenience for older people without (at least with reduced) stigmatisation of ageing, and having them maintain a certain level of economic self-confidence, a stable life, and an identity of independence.

9.3.3 The pursuit of active ageing and health technology participation

The World Health Organisation (WHO) (2002) introduced the concept of "active ageing", in which "active" means "continuing participation in social, economic, cultural, spiritual and civic affairs". It extends from interactions with like-minded people in small-scale activities to social participation that is "continuing" (more frequent), "geographically broader" (not only localised to older people's communities), "involving a wider range of issues" and with "a more diverse set of interactions" (not just acquaintances).

As the vision of "healthy ageing" comprises a yearning for, and a partial compromise on the level of health once enjoyed at a younger age, and the vision of "successful ageing" appears to be a maintenance of stable lives, "active ageing" tends to be more of a resistance to the physical and psychological change of ageing and the stereotypes of passivity, and even

embraces fresh attempts to do things that were not attainable in youth (Foster and Walker, 2015). Older people in interviews touched on how improved social conditions and a more settled life enabled them to have more opportunities and willingness to travel and participate in public service, which they could not manage when they were young – the transport was underdeveloped, they were busy with work and their subjective wishes were suppressed. Wang (2023, p.217) described the preservation of self-interest and the difficulty of uttering personal preferences because of political and social reasons in the years when older people in China were growing up. They may only have control over their lives in old age when the policy and the society become open enough to freely express their personal feelings and criticisms, thereby achieving “active ageing”.

Indeed, through an overview of older people’s attitudes on ageing and lives in old age in the interviews, it can be found that their claims to active participation are not well pronounced, compared to healthy and successful ageing. It may be that “active ageing” is essentially an “extravagant” and higher-order need, which is not only based on the premise of personal health, but also places high demands on the social environment and policy, and can vary by socioeconomic conditions (Foster and Walker, 2015).

Active adoption and rejection of health technology can serve as a manifestation of active ageing. Liu, et al. (2021) identified that older people having more Internet access devices have a higher level of social participation and active ageing, which can lead to improved physical and mental health as well. Most emerging health technologies were not available in older people’s past lives, and curiosity and exploration of new things are part of older people’s technological freedom to always be productive and creative, although few older people admitted to purchasing and using health technology out of curiosity,

unlike young people (e.g. one of the caregivers said, *"I use the smartwatch for fun"*, p.221). On the flip side, the active rejection of health technology also represents the articulation of older people's opinions. A prevailing idea that contradicts adopting technology as a means of active ageing is that technology can reinforce social isolation (Turkle, 2005, p.129). Some older people's preference for human caregivers over health technology may implicitly reveal their objections to technology-induced social isolation. In addition, some research tended to blame older people's non-use of technology on certain barriers and see their withdrawal from technology as a risk (e.g., Yusif, Soar and Hafeez-Baig, 2016; Wilson, et al., 2021) while ignoring the active role of older people as "non-users". But just as radical non-drivers can actively advocate for the desirability of car-free spaces (Wyatt, 2003, p.68), some older people as non-users of health technology can also actively contest the technology. Older (non-)users' agency in health technology will be further discussed in section 9.4.

There are also several cases of passive-accepting health technologies, which may conflict with the concept of active ageing. The acceptance of the Health Code by older people (and not even just older people) stems almost exclusively from the Chinese government's requirement to control the outbreak of COVID-19. Although older people showed some activeness by responding to the initiative and learning the Health Code, their use of the Health Code was a bit mechanical and numb when the government implemented normalised epidemic prevention and control; it was only after the regulations were lifted that older people started to dispute their previous attitudes and look more critically at the use of the Health Code. Similar situations exist with regard to the use of other health technologies, especially when devices are purchased or installed in their residential environment by other people, or when alternatives to the technology

are restricted (e.g., most in-person healthcare services were switched to online during epidemics), and older people's willingness to independence choice and planning is challenged. Those acquiring and installing technology for older people may put themselves in a position of superior knowledge of the technology and to a certain extent obliterate the subjective thoughts of older people who are "unskilled" at technology (pp.230-231). Policymakers who restrict technology alternatives may not have considered external constraints on older people's use of technology, such as lack of Internet access and technology literacy (Pirhonen, et al., 2020).

Participation in the development of health technology is also an approach to achieve active ageing, as older people hope to make technology and their own lives better by expressing their opinions. However, my findings reveal a low level of participation in both China and the UK, and the acknowledgement of older people's self-value and creativity is not evident in the participation. It can be identified that there is a lack of environments and conditions for participation, which resulted in the inability of older people and technology workers to have direct and effective communication. Even where opportunities for participation are provided, the effectiveness of older people's participation is not endorsed (pp.274-277). As section 9.2 shows, this may be due to the power imbalance that persists in older people's participation in health technology – technology companies and workers label themselves with the "leadership and the right of final interpretation" of participation, leaving older people in a disadvantaged position with little priority for voice, and thus diminishing their motivation to participate. Bryson (2015) suggested that to realise active ageing in older people it is necessary to facilitate their technological participation by asking them what they would like to contribute and establishing relevant infrastructural safeguards, including lifelong education and community volunteering culture.

These ideas not only place new demands on technology companies but also emphasise the need to further integrate other social security systems into the nexus of active ageing and participation in the development of health technology.

Considering older people as a group with diversity, we can see how attitudes towards active ageing influence participation in the development of health technology. Older people who are more supportive of active ageing are more enthusiastic about participating in all sorts of political and cultural affairs and prefer to be free to express their views on health technology, or even to organise health technology participation activities on their own, and to become opinion leaders who bring about technological changes (p.208). Kim, et al. (2017) found that older women were more likely to be formally involved in organised activities, which correlated with their more active use of IT for health matters. In the absence of large-scale quantitative surveys, it is unclear how health technology participation links with other personal factors of older people. Still, it is foreseeable that differences in gender, education, and socio-economic conditions that present therein could create new inequalities in health technology participation and the conceptualisation of active ageing.

9.3.4 Pessimism about ageing: mutual reconstruction of health technology and the concept of ageing

The above three sections discussed how positive attitudes towards ageing are related to the acceptance and participation in health technologies, but in interviews, I also found some older adults with pessimistic attitudes towards ageing. These pessimistic attitudes are embedded in perceptions of health technology in a very assertive way, leading to glaring contradictions between

the design objective or script of the health technology and the actual feedback from older adults.

Several older people have no intention of staying healthy and just allow the disease to progress with little control measures. Some of them may believe in fatalism, assuming that the trajectory of a person's life cannot be altered by a positive attitude, while others are constrained by external conditions, such as suffering from a disease for which there is currently no effective cure or not being able to afford the cost of maintaining health or treating disease. These people would feel that health technologies are unnecessary because their benefits are quite limited (e.g., they thought they would be more willing to adopt health technology if it could help cure diseases, in which case they might only get the technology once they were ill), and instead magnify the disadvantages of owning health technologies, overriding the advantages of the technologies with concerns such as high price and technological complexity. It is also possible that they have never been exposed to health technologies in their lives because of a lack of attempts to find means to improve their health or a lack of social conditions that would allow them to be exposed to the technologies (for example, living in an isolated area, where no one else is around to use health technologies, and there is no condition to deploy socially-oriented technologies such as online healthcare – it is notable that although China is quite developed now, there are still large social gaps, and during the COVID-19 pandemic, there were areas where the Health Code were not used at all). There are also older people with ambivalent attitudes towards healthy ageing, who commonly hold the view that "health is a self-perception" rather than "medical data" (p.139). The literature review of my research shows that personal health can influence older people's acceptance of health technology (e.g., Li, et al., 2019). Considering older people with ambivalent attitudes towards healthy ageing,

self-awareness of health can be added to this factor, as people who trust more (or overly trust) in their self-awareness of health are likely to develop a distrust and low acceptance of health technology.

Some older people do not have an expectation for successful ageing and consider poverty, loneliness and dependency as part of ageing (although we have learnt that these are not inevitable outcomes of ageing, as many older people are even more affluent, spiritually fulfilled and independent than their younger counterparts), which contributes to negative attitudes and reservations about health technologies. Their socio-economic and living conditions are incompatible with the deployment of health technologies, as they cannot afford the cost and their residential areas and routines may not be receptive to the intrusion of health technologies. They do not have the desire for health technologies to increase their social interactions. When being cared for, they may be more inclined to accept human caregivers than to create new spaces for ageing with technology, in a passive state of “using whatever I have” rather than “using what I can think of”. Conversely, these older people may require more from health technology-related policies and technology development by companies, because if the government were going to deploy socially imperative technologies, these older people would have a great need for the cost to be regulated, may not actively look for means to learn the technology but need companies to produce guidance and comprehensive coaching at the societal level.

Negative attitudes towards active ageing are more evident among the interviewees, especially among older people in China, many of whom would not like to participate in socio-cultural affairs, pass on advice and take on social responsibilities, but just want to live their own lives, and are hesitant to be

interviewed. When it comes to technological participation, they tend to think of it as young people's business, emphasising the contradiction of "old" age and "new" technology and devaluing their roles as technology participants (this may also be related to the democratic nature and cultural values, see section 9.1.5). Unlike the situation described earlier, where older people have a willingness to participate but are restricted by contextual conditions, some older people are in complete denial about the desire to participate and the necessity for older people to participate (pp.161-162, 209-210). This may be due to their anticipation of constraints, limited effectiveness of participation and the predicament of expressing autonomous will in the past is still deeply rooted in their minds. They indicated after the formal interview that they were willing to be interviewed because the researcher (I) constructed a safe and relaxing space for communication, clearly explained the reasons why their opinions were important, and gave them a sense of self-value. The comparison between agreement to participate in interviews and negative attitudes towards technological participation prompts possible limitations in technological participation and suggests that older people's negative attitudes towards participation may not be static. For health technology workers and researchers, if they wish to involve more older people in the development of technology, the construction of the environment and the need for participation is important, as well as striking a balance between older people's autonomy, requirements, and the distribution of power in their participation. In other words, older people's pessimism about active ageing and non-participation may also shed light on technology participation and the techno-social development.

Each of the three sections above has broken down the roles that health technology and health technology participation play and the limitations they create for healthy ageing, successful ageing and active ageing, which may also

change and reinforce pessimistic attitudes towards ageing. It can be deduced how health technology (and the social system in which it exists) and the different concepts of ageing shape each other. As both the concepts of ageing and health technology will continue to evolve in the future, researchers should always incorporate their complex interactions into the studies of technology acceptance and participation, to better establish the inclusiveness of health technology for ageing.

9.3.5 Ageing as a feeling and the use of health technologies

The definition of older people at the beginning of this research (and in most other studies) is based on age, and it is on this basis that the study population was selected. However, the interviews and focus groups revealed interesting phenomena: some traditionally defined “older people” do not consider themselves as ageing, maintain a fairly youthful mental state, or believe that the ageing process is malleable (Brown, et al., 2023); on the contrary, some interviewees in the second and third groups who are in their young adulthood or middle age behaved in a similar way to older people, including but not limited to fully understanding and practising the self-care behaviours of older people, lacking enthusiasm and displaying numbness in their work, and even longing for retirement. These two mindsets of ageing, which appear contradictory to biological age, also play a role in co-production with health technology.

For older people with younger mental states (who may sometimes resist the designation of “older people”), their patterns of using health technology may be more like those of younger adults (how young people think of and use health technology, as exemplified by caregivers and technology workers interviewed, has already been discussed in section 9.2), and they may even consciously exclude themselves from the social stereotype that “older people do not know

how to use technology". On the one hand, they would like to stay young and healthy through the use of health technology, and when the technology meets their expectations in this regard, they will evaluate it positively and recognise the necessity of health technology research and development. On the other hand, they are the most opposed to health technology's connotation of ageing, resisting both human caregivers and health technology for ageing in place. Whether or not to categorise this group as "older people" may be debatable, but it manifests that there will be problems with taking age as a single criterion when considering potential users of health technologies for ageing.

For young people who have an older mindset (which may be quite common but has not been fully investigated and is referred to in Chinese social networks as "composite ageing youth" or "brittle young people"), their use of health technology can be akin to that of other older people. They have an explicit need for and even dependence on health technology, which can become a very natural part of their lives when they are also very skilled in using technology. However, because what they perceive as "an older mindset" is largely grounded in a sense of humour and self-deprecation, they are not likely to argue strongly against the stigmatisation of old age by health technology.

Brown, et al. (2023) observe that research on the mindset of ageing (MA) is still in its infancy, and it is not known how different mindsets of ageing (growth or fixed) impact a person's life trajectory. My study provides an initial discussion of this, and it may be an aspect of ageing and technology research that is worth continuing to explore.

9.4 Actor-network and agency: how much agency is given to different groups of people, health technology and other parts of the health technology system?

In section 9.2, we discussed the similarities and differences in the perceptions of the three groups interviewed about the relationship between older people and health technology and how these perceptions are constructed. I introduced the concept of actor-network theory (ANT) in the literature review, and it inspired me to focus on how the interests of each actor in a technology network are manifested and intertwined, which will help me better understand the process of older people's acceptance and participation in health technology. The "actors" are not only the three groups of human beings interviewed but also include non-humans, such as the health technology itself, the healthcare sectors (hospitals, GPs), and policies related to health technologies, etc. ANT suggests to "trace networks as well as to detect stabilisation mechanisms during certain moments of networks' interactions" (Baron and Gomez, 2016), and this section will therefore take the "moments" of these interactions as clues to discuss the specific behaviours of each actor, their translational relationships, and the problems that may exist within them. These moments include older people's initiation of health technology, continued use of health technology, abandonment of health technology and participation in the development of health technology.

9.4.1 Older people's initiation of health technology

Attention to older people's prompts to accept health technology helps to understand their agency and the ability to shape the network in the initiation of health technology. At the stage of initiating the use of health technology, the simplest scenario is that older people are completely independent new users of the technology, with direct end-to-end interactions with it. Such situations are

very rare, or almost impossible in practice, as it is unlikely that older people's demands of health technology will appear without any motivation. However, I found it interesting in the chapter on older people's purchases of digital health devices that their first response was that "the technology product was purchased by themselves" even if there were other introducers or purchasers (p.132). This is a good illustration of the amplification of self-ownership of the technology and the mentality of control over the technology product in the initial stages of older people's acceptance of health technology. For older people, the act of purchasing health technology on their own initiative may confer a strong and independent position on themselves in the technological network and simplify the network by erasing the roles of other actors. However, Selwyn (2004) found that older people are unlikely to purchase technology on their own.

Caregivers are often added to the network of older people's initiation of health technology as introducers, certified by both older people and caregivers themselves. Caregivers are sometimes the "duty-bearers" who initiate the purchase of health technology for older people and are in the dominant position in the network ("*He was using it so well that he bought one for me too"*, p.132), and when this role disappears, the interactions between older people and health technology disappear in parallel; they are also sometimes passive (or intermediary) introducers, situated in the middle of the link between older people and health technology (" *(My father-in-law) was the one who asked me to purchase the blood pressure monitor"*, p.229), and when this role is unavailable, older people may look for alternative intermediaries in an attempt to develop a new technological relationship, may actively create a more direct connection without intermediaries, or give up the establishment of the technological network. Where caregivers are successfully added to the network, successful translations usually unfold as well (i.e., interests are successfully

negotiated between actors) – older people appreciate the introductory roles of caregivers, and there is good acceptance of technology (Lee and Coughlin, 2015; Outila and Kiuru, 2020). Unsuccessful translations, however, show the ambivalence of both older people and caregivers in their perceptions of their roles, or their perceptions of the technology, which results in "technology redundancy" (Coleman, et al., 2010). For example, the dominance of caregivers is not acknowledged by older people, who have implicitly independent judgements about the technology, and the intervention of caregivers becomes an interference instead (there is a case where one older person did not like the smartwatch bought by his child, p.230). In the tripartite relationships of older people, caregivers and health technology, the perspectives of the two human actors can be entirely distinct, with obvious transfer and fluctuation of power (the role of technology will be explained later on). Although ANT was supposed to favour an agnostic approach to explanations, values and power in the networks, I adopt López-Gómez's (2019) shift from ANT to the care repertoire to make power struggles visible. We see a typical example of the power struggle from interviews. That is, caregivers may assume that they have a dominant role in the process (possibly with more technological knowledge and access to technology and resources) and try to manipulate older people's adoption of health technology. However, when older people start to use technology, they have its ownership and gradually take on more agency and power to make decisions, which weakens caregivers' roles (sometimes due to eldership pressures or employment relationships).

For relatively organised rather than personalised health technologies, or in the absence of caregivers, the actors that intervene in older people's initiation of health technology are likely to be people in healthcare organisations (e.g., hospitals, GPs) and technological support projects (such as EIDS), and

policymakers. It was mentioned in the literature review that recommendations by healthcare professionals are an important source of information for older people when accepting the telemedicine system (Cimperman, et al., 2013). Physicians' recommendations for older adults' adoption of digital health technology and hospitals' decisions about incorporating online health systems and electronic health records for public use are also identified in my research. In the former case, the mobility of power is similar to that of caregivers, as physicians are the source of information but not necessarily leading to adoption. In the latter case, however, people in healthcare organisations are the actual creators of the technology network, who can regulate the availability of the technology and older people's (or the patients') identities as technology users relying on relevant technological policies, while the users' agency is limited. In the case of failed translations, older people are left to self-regulate by seeking help from other actors who have successfully established connectivity (pp.118-119), or to urge healthcare organisations and policymakers to make changes (e.g., the introduction of paper certificates as alternatives for the Health Code), but healthcare organisations and policymakers remain the de facto power in the network. Technological support projects may play a role in helping the translation, and they may selectively cascade certain actors in the network (e.g., caregivers and technology companies were asked to install the technology for older people in the EIDS project) in order to reconcile the relationship between older people and health technology.

At the stage when older people are introduced to and start to use health technologies, the non-human actors at play are technology, policies, illness and discourses about care. The proactive role of technology has often been ignored in the literature on public acceptance of technology – as can be seen in the literature review, scholars tend to assign more power and explanations to the

actions of humans. However, ANT emphasises the active role of technology through positional change in the network rather than considers them as a passive “black box”. Cresswell, Worth and Sheikh (2010) illustrate how the introduction of electronic health record software radically changed the way the healthcare team operates, because nurses who previously ordered x-ray requests on paper forms would be limited in their access to the new system and consultants would have to take over the job. Similarly, in my research, smartwatches, health apps, and health technology for ageing in place are also proactive in their introduction and to some extent alter the relational configuration of families, for example by attempting to replace older people’s autonomy and some of the caregiving work of human carers. The introduction of the Health Code and the online healthcare system is driven by policies, as their production and configuration demonstrate a political appropriation that amplifies their importance in the network by mobilising people and reassigning health responsibilities to the user (Liu, 2022). In addition, Interviews with technology workers revealed that technology companies play a limited role in older people’s initial adoption of health technology but are more likely to be hidden behind the technology, as they do not make decisions about the allocation of technology and the shifts of responsibility (the networks encompassing technology companies are usually built before and after older people accept the technology).

In addition to technology, connotations of frailty arising from deterioration of bodily functions and illness, and the social attributes of healthcare (including the feeling that the hospital is inauspicious) also play a key role in older people’s initiation into the use of health technology. Research has evidenced the relationship between bodily deterioration, the need for care and the sensation of shame, which can further lead to sentiments of alienation and loss of identity

(Mantzoukas, et al., 2021). In my study, older people's attempts to manage the discomforts of illness, psychological shame and embarrassment, and the hassle and inauspiciousness associated with visits to hospitals are at the origin of their need for, and trial of health technologies. Not only does the illness itself work, but it also exerts greater power when encircled by social and technological systems. Martin, Myers and Viseu (2015) point to the dark side of "care", arguing that acts of care could embroil in complex politics and even commit violence. Concerns about ageism and stigmatisation of technology support this argument from two perspectives, and older people's adoption of health technology is in response to, or a challenge to these concerns.

From the analysis of the actors above, the network of actors tends to be unstable at the stage when older people are introduced to and begin to use health technologies. There is a considerable amount of translation, linkage and overriding between actors. This process of technology communication is dissimilar to common information communication, which is mediated through an information-feedback loop (which is fixed) between the communicator and the receiver and includes a number of environmental elements known as "noise" (Shannon, 1948), which are often unwelcome because they influence the loop. In the technology communication system, none of the elements are in a fixed position and none of the relationships are stable, and the "noise" is visualised as dynamic actors that play their respective roles in technology adoption. The figure below illustrates a network model of older people's initiation of health technology. As Law (2008, p.153) suggested that the network should be loosely associated without a need for a centre, I put all actors in a circle to assign every human or non-human actor the same status and avoid any of them dominating the network. The position of the bubbles is fluid, and the lines can represent two-way interactions (but are not always available).

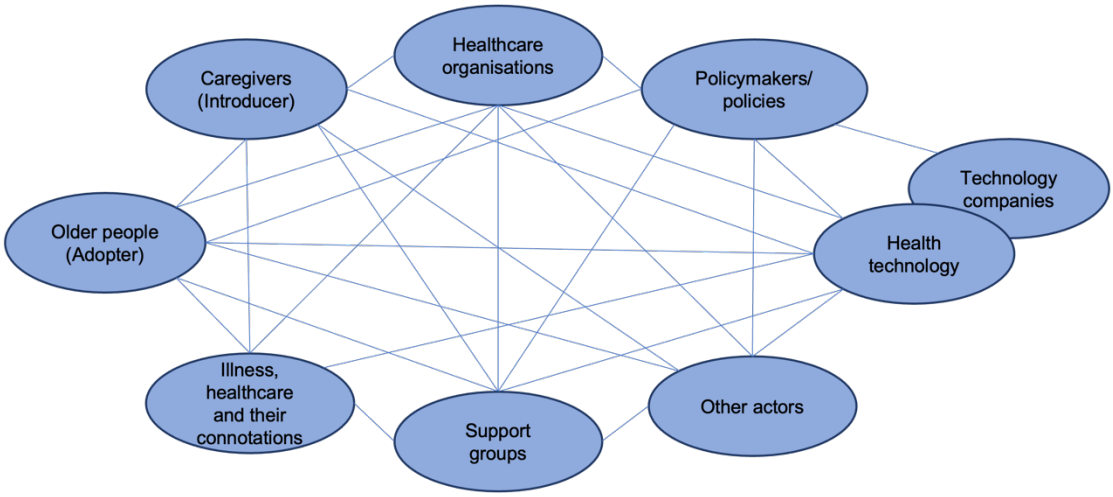

Figure 8: Possible relationships between actors in the network when older people are introduced to health technology

It should be further noted that there are disparities in the construction of networks in China and the UK based on the contextual differences discussed in section 9.1. For example, as only Chinese older people mentioned the inauspicious attributes of hospitals, the role (and agency) of illness (in particular the claim for independent control of illness) is not evident in the UK.

9.4.2 Continued use of health technology by older people and the stabilisation of user identity

As older people gradually adapt to the use of health technology, a new network emerges in which the roles and connections of different actors begin to change, and older people's user identity becomes stable. Some older people remain active in their interaction with technology and become independent and skilled users of health technology, effectively embedding it in their daily lives and empowering themselves to take control of their health. The technological discourse is successfully translated, and the technology helps older users to achieve their goals, or older people are co-opted into the technology's goals

(Outila and Kiuru, 2020). Maller (2015) explains the materiality of technology in health behaviours, as the “agency of things in social practices is directly associated with their material presence and plays a coordinating role in the integration of other elements”. In the context of successful translation in my research, the agency of health technology is demonstrated in the daily reminders of health habits from smartwatches and health apps, which may partially replace older peoples’ memory; the changing colours of the Health Code based on big data, which assigns the user free access to public places or controls the user in the quarantine; the amplification of older people’s bodily functions (e.g., fall alarms can be seen as amplifying older people’s voices, health monitors can be seen as signal-based amplification and visualisation of older people’s feelings); the support or restraints of independence and identity by telehealth (Bowes and McColgan, 2013); and healthcare robots that may be available in the future may even have more autonomy as generate real-time responses to commands given by the user or replace human carers (Stahl and Coeckelbergh, 2016). When older people successfully appropriate health technologies, it may seem that there are only two actors, but there is always a continuous flow of financial support, technical support (including the role of health data) and behavioural support behind the scenes.

Caregivers are one of the main actors who can provide support. After acquiring and inducting older people into health technology as introducers, their roles as trainers, guardians and coordinators continue to influence older people’s subsequent use of the technology, in which there is a possible flow of responsibility and power going in the same direction. That is, when caregivers take on the responsibility of coaching, guardianship and coordination, they also naturally get the power to control and organise the interactions between older people and health technology, while older people seek a trade-off between

obedience and independence (Luijkx, Peek and Wouters, 2015). It is only when the flow is recognised by both older people and caregivers (older people recognise caregivers' mentorship and reverse feeding, and caregivers provide strategic technological support) that the translation can be successful. However, Carlo and Bonifacio (2020) found that intergenerational teaching is not sufficient to transform the status and authority of young and old. Hence there is the potential for older adults and caregivers to undermine the technological network by destroying the relational foundations needed to build successful translations, such as inadequate communication between the two actors, older people challenging the authority of the trainers, or caregivers refusing to teach. Throughout the ongoing interactions between older people and caregivers, I observe that it is difficult to ascertain by whom caregivers' (potentially excessive) roles, responsibilities and power are assigned. It appears that both parties find this to be a series of natural occurrences, but no contract or inscription binds the relationship, and caregivers do not seem to be reaping any tangible benefits from it. I analogise this to an osmotic effect with relational proximity, where more relational responsibility and more technology skills can be analogised to higher osmotic pressure, arising from individual initiative and sociocultural expectations (e.g., filial piety).

Caregivers' assumption of responsibility for teaching health technology also demonstrates the absence of technology companies in this process. While older adults expressed a desire for systematic and tailored technology training, and researchers called for technology companies to offer technology classes or workshops for older adults (Kim, et al., 2016), the technology workers interviewed did not seem to feel that they should teach older people about technology. In other words, technology workers and older users see "successful translation" differently in this network. Technology workers, who have

embraced technological expertise, may believe that assembling technology (interfaces, accessories, technology logic) is sufficient for successful translation. However, successful translation for older users requires each actor to be responsible for the various interactions between them and technology. In older people's use of health technology, the most significant action by technology companies (and technology) is rather the collection of health data, as technology workers embed the action of data collection in health technology and attempt to rationalise this behaviour (p.278). Once users consent to the collection of data under prescribed privacy terms, technology companies obtain the "legitimate power" to store and process data, as well as a potential to sell the data for secondary uses (Kaplan, 2016). Technology companies are, in fact, constructing a network in which users should comply with data collection. The agency of health data, in the meantime, can be reflected in its transfer of power.

Other important actors that play a role in older people's continued use of health technology include socio-technical partners, discourses, and policies. Older people interact with social circles that share the use of health technology, for example by "liking" each other's exercise data (p.142), which reinforces the social relationship and also creates incentives for sustained use of health technology. They request repairs, updates and technical support when there are problems with technology (sometimes also by caregivers and technology workers). They also interact with broader social policies and socio-technical perceptions. For example, while policies exert their agency with regulations on the mandatory use of the Health Code, older people either respond to or question them. Successful translation (the maintenance of stable technology user identities) often requires actors to trust their alliance (older people to trust partners and policies) (Callon, 1984, p.224). However, I found in my research that the translation is not always robust, as technical support is not always

available, and technology policies change from time to time. For example, as soon as the Health Code becomes incorrect, or the administration of the Health Code becomes lax, older adults will negate the necessity and usefulness of the Health Code and abandon their connection to it. Latour (2007) argues that social ties are weak and elusive but that they can be stabilised through material objects, which is validated in the example of WeRun to expand social contact. However, in the cases above, as each actor (including the technology) is alterable without everlasting standards and formats, social relationships cannot actually be solid.

The successful connection between older people and health technology is marked by the simultaneous realisation of the interests of the actors in the network, such as older people achieving their health goals and health technologies fulfilling their tasks. This successful connection draws on, and may also contribute to, an integrated sociotechnical imaginary (see definition on p.284) of a digital health society, which has been a policy goal in both China and the UK (National Health Commission, 2022; NHS England, 2022). In this sociotechnical imaginary, social responsibility for maintaining healthy and successful ageing can be transferred "equitably" to different actors, with a manageable balance of autonomy, but our society is far from achieving this goal in the current context. Furthermore, Lipp and Peine (2022) argue that ageing is sometimes co-opted as a justifying background to technological policies that are essentially designed to stimulate innovation and prevent the "disadvantages" of the ageing society, rather than to benefit older people. Therefore, the agency of actors in the network is not entirely active but is rather subject to various, particularly policy-based constraints, and is generated and transformed by socio-technical arrangements. The figure below illustrates a network when older people and health technology are successfully connected,

where the solid lines still represent two-way interactions, and the dotted lines indicate the ambiguity and uncertainty of the existing relationship (e.g., shifting of responsibilities between caregivers and technology companies). At this stage, the main difference between China and the UK is data collection (see 9.1.7).

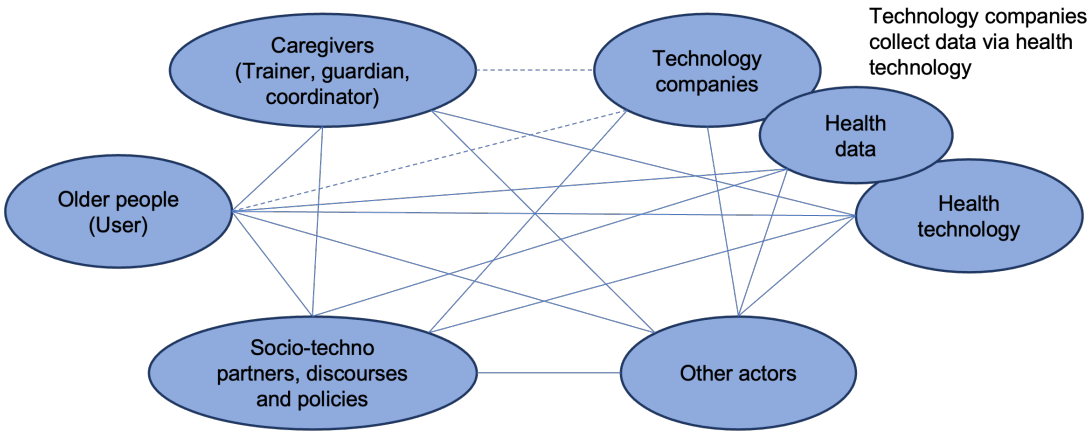

Figure 9: Possible actor-network when older people stabilise their use of health technology

9.4.3 Non-use and abandonment of health technology by older adults

Non-use and abandonment of technology may stem from translation failures and be seen as a disruption to the network (Outila and Kiuru, 2020) or friction situations (López-Gómez, 2019). At each step of the way from introduction to adoption and use of health technologies by older people, there is a chance that actors may obstruct or not act, leading to partial or fundamental disintegration of the network (even if older people are never exposed to health technologies, the network potentially exists, but there are reasons hindering its establishment).

Wyatt (2003) reconstructs four types of technology non-users, including "resisters" who do not want to use the technology, "rejecters" who voluntarily stop using the technology, the "excluded" who are unable to get access, and the "expelled" who stop using involuntarily. In my study, these four types of non-

users of health technology are all well-represented (even with the subtle addition of the fifth type of “uncertain non-users”, such as residents of remote areas who are not mandated to use the Health Code). The first two types of non-users (“want nots”) are considered in the usual sense to have more agency and a stronger awareness of self-selection, while the non-use of the latter two types (“have nots”) is attributed to passive choice under technological inequality. With the interview material, I can further subdivide “want nots” into “active want nots” and “avoidant want nots”. Older adults who “actively” reject the use of health technology often have a comprehensive understanding of the technology and can explicitly give the reasons for why they do not want to use it. They can play an “active” role in shaping the technology by interacting with technology developers, and it is also possible for them to reverse their identity as non-users and embrace the health technology once the technology is improved according to their advice. Conversely, “avoidant want nots” do not necessarily fully understand the technology and they may not be able to articulate why they do not want the technology (e.g., *“she just wanted to take it off”*, p.264), but there may be a deeper and intrinsic belief in technological pessimism (or neo-Luddism) (Jones, 2013), and their non-user identity is unlikely to be altered. Their agency is not developed in interactions with technology workers but in their demand for more inclusive technology and ageing policies, such as implementing an elastic policy for the use of the Health Code (Liu, 2022). Similarly, the “have nots” can construct their agency through “loss” in the unequal context, especially when policies “require” them to use health technology, they can exert pressure to systematically differentiate responsibility for technology inclusion by leveraging their distance from the technology and their fragile relationship with other actors in the network. The agency of non-users may rarely be taken into account in the deployment of technology, as they are often difficult to locate, are not very cohesive, and have diverse and

personal reasons for non-use (Wyatt, 2003). However, the identification and power of non-users are still important in technological development, policy-making and social change because they at least fundamentally set up the discussion on the necessity of using technology and the advantages of technological access (e.g., Verdegem and Verhoest, 2009). In this case, we may need to re-examine the concept of technology exclusion, as non-users are not simply downgraded by exclusion, but are sometimes able to proactively rearrange their position in the network.

Indeed, my research also identifies a large number of older people who are in the borderland between stable users and non-users, and I would like to call them “partial users”, such as using always under coercion, guidance or dependence of others, not following the prescribed scripts for health technology (e.g., using the smartwatch to see the time only without performing any health features, using the technology without setting it up successfully), and leaving the technology almost unused after purchasing it. These “partial users”, like non-users, either show resistance to the technology or are “not able to” use the technology by themselves. In technological networks, these situations indicate the fragility of relationships between older people and other actors but may also create new relationships and technological paradigms. An example of this is the dependence of older people on their children for medical appointments, where older people can be considered “partial users” of the digital appointment system. In this network, the relationship between older people and technology is precarious, but this may bring the relationship between older people and their children, and between children and technology, closer together, as well as make technology workers and policymakers reflect on whether such guardianship is feasible and the ethical framework within which it needs to be implemented.

In the situation of older people as non-users or partial users of health technology, caregivers may present as inactive (e.g., *"we've been slightly ignored"*, p.177), active but useless (e.g., *"I tried to fix it for them but failed"*, p.232), supportive of non-use (e.g., *"It's okay for older people not to use them"*, p.221), and as technology reclaimers after the situation has occurred (pp.235-236). Therefore, my research confirms Greenhalgh, et al.'s (2013) argument that the absence of caregivers in the role of bricoleur is an important reason for the unsuccessful connection between older people and health technologies. Support for non-use encompasses two situations: the departure from technology that caregivers share with older people, and an adequate representation of older people's identity, in which the agency of caregivers is noticeable. Caregivers' role as technology reclaimers is produced by the circulation of technology in the network and based on unsuccessful translations between older people and technology or between older people and caregivers. They are somewhat like passive recipients of technology and lack agency, but are subject to the redistribution of technology, which is more often found in older people's situations (Selwyn, 2004).

Previous literature has paid little attention to the agency of technology companies in the network of non-users. My research found that technology workers knew the presence of older non-users and tried to address some of the barriers to older people's adoption of the technologies, but they also expressed their powerlessness in many situations. The instinctive advocacy for technology and the actual lack of structural power creates a paradox[27], and it is further

[27] The technology workers have very positive attitudes towards technology, but in their jobs, most of them are following their leaders or the company goals of producing technology without the power to actually make decisions, so it is unsure whether their advocacy for technology is out of themselves or out of their interest which goes together with the companies.

exacerbated by the overly specific distribution of responsibilities in the technological system and the lack of clarity of responsibilities associated with techno-social issues. Ageing and technology policies may still work in the network, but actors do not necessarily respond to the policies.

For the network of non-users, the agency of technology is mainly reflected in the restrictive role of functions and data. The functional limitations of the technology lie in the complex operation, useless items and operational errors within it, which results in the disruption of translation. For example, older people who only use digital health devices for blood pressure measurement without uploading data may, as “partial users”, be subject to the functional complexity. The data limitation refers to the technology’s mandatory collection of health data and companies’ subsequent exploitation of data like a black box. Neff and Fiore-Gartland (2015) proposed the concept of “data valences” in digital health, referring to the multidimensional expectations and values that different stakeholders place on the social and material performance of data. Therefore, data valences are constantly changing in older people’s use and non-use of health technology, according to the desired values of different actors, and are limiting actions that can be performed by technology users. For example, non-users of the smartwatch have concerns about the conversion between data and health (the “inscriptions” are not well-developed) and about the flow of data collected, even considering the possibility of digital fraud. Although technology workers believe they have explained data collection to some extent by embedding privacy terms and conditions in the devices or health apps, there are still many problems, such as small font sizes and lengthy texts. Or we can say that doubts and struggles about data collection (or the agency of data) are always an essential reason for translation failures in the network. Non-users are found to be more concerned about data misuse (Lidynia, Schomakers and

Ziefle, 2019), and it creates distrust of technology companies and demands for developing better data protection policies (Ilhan and Fietkiewicz, 2021).

Overall, the technological network of older people as non-users and partial users demonstrates the inconsistency of the subjective motivations and interests of actors, as well as instability in interactions. Such unstable interactions can also, in turn, transform the actors' goals of interest, such as technology workers may go from persuading older people to adopt health technologies to abandoning the market for older people (p.260). In such a network, I tend to depict all the relationships between actors as dotted lines (below), but this does not imply an inevitable failure of translation between them. For example, there may still be a well-established affiliation between caregivers and health technologies, but it is not transmitted to older people. In addition, although the topic of data stems from health technology, data can actually move around the network and change the relationship between actors; the potential role of illness and care discourses still exists and is included in "other actors".

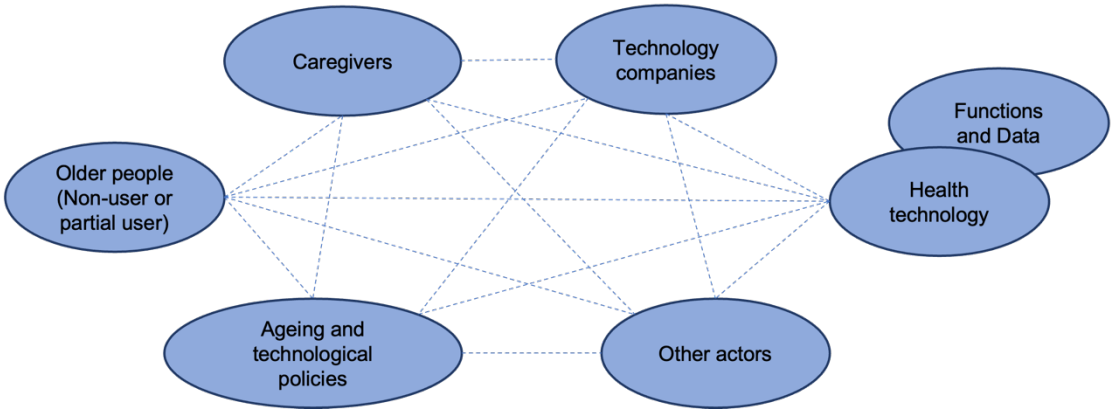

Figure 10: Possible actor-network when older people are non-users or partial users of health technology

9.4.4 The network of older people's participation in the development of health technologies

In contrast to the usual invisibility of the role of technology companies in the adoption and use of health technologies by older people, when older people become participants (and non-participants) in health technologies, older people and technology companies are the main “scaffolders” of the actor-network, with active output centred on health technologies (British older people more than Chinese older people). Caregivers assist in this process, sometimes interacting directly with technology companies and technologies. Policies may also influence participation by deciding its scale and format.

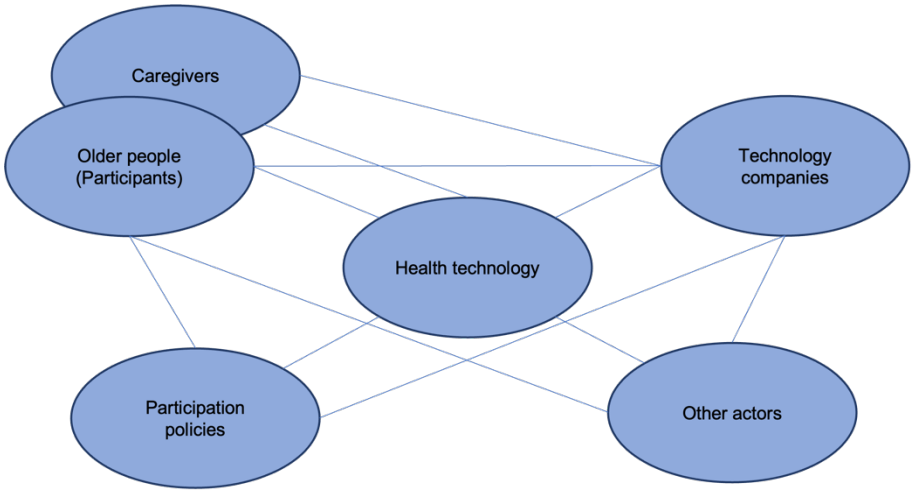

Figure 11: Possible actor-network when older people are participants in the development of health technology

I have already discussed in section 9.2 the different perceptions of older people, caregivers and technology workers on older people’s participation in the development of health technology. Each group identified their agency and power in the participation in interviews, and there were people in each group who believed that they should have more power than the other actors and take a dominant role in technology participation. However, the agency of actors in technology participation is highly imbalanced, as technology companies tend to be the spokesperson in the network (De la Harpe, 2014). The power subjectivity

not only contributes to older people's different assumptions of participation (as discussed in section 9.2) but also potentially widens their gap with the participating groups. According to interviews, older people's agency is only manifested before and during participation, i.e. in deciding whether or not to participate and how to express themselves in participation (and more precisely, in both of these areas older people do not necessarily exercise their full agency, because there are governed modes of participation), but they are not able to intervene in the outcome of participation (just like there is no way of knowing how the uploaded health data will be used). In contrast, technology companies (and technology-related policies), as presented by technology workers in interviews, can essentially control the entire process of participation, including defining at what stage and at what scale older people should participate (sometimes with incentives), and to what extent they should interfere with the freedom to participate and utilise the results of participation. Even in technology participation led by older people or caregivers, technology companies and related policies are necessary components and more flexible and autonomous players (e.g., *"...with technology developers aside"*, p.208). This allows them to develop a higher status and a lack of humility in the participatory network, which can lead to a compression of the capacities of other actors and difficult translations (e.g., too technical) (De la Harpe, ibid).

Wilkowska, Brauner and Ziefle (2018) explores responsible innovation in smart technologies for older people, focusing on user-centred smart homes and health-monitoring systems that enhance independence, health management and well-being. This research emphasises the need to incorporate responsible research and innovation (RRI) into older people's technology, voting for the inclusion of older adults in a bottom-up process and the consideration of users' diversity in order to build a long-term success of the user-technology interaction.

The concept of RRI further elucidates the importance of coordinating the power and relationships of actors in the participatory network and the involvement of users throughout the healthcare innovation, although it is still an academic conceptualization and is institutionalised to varying degrees in the Europe (Demers-Payette, Lehoux and Daudelin, 2016; Owen, Von Schomberg and Macnaghten, 2021). One of the barriers to the successful implementation of this framework, however, is that most researchers and technology workers do not have a clear idea of what the process looks like and how it might impact their daily practice (Stahl, et al., 2014). Some technology workers have suggested some ways in which RRI can be better integrated into older people's participation in health technology, and I can organise them as 1) making it possible for not only users but also non-users to participate in technology at all stages, as non-users also have agency to propose ideas (*"we would prefer those who are not skilled in technology to have a trial"*, p.267); 2) creating better translations between actors and getting actors to be more aware of each other's presence and roles (including establishing rapport, overcoming ethical and cultural challenges, pp.272-274), to enhance the effectiveness of interactions; 3) there is an internal appraisal in technology companies (*"we will be held accountable if we lose too many users"*, p.275), which increase the weight of feedback and inspire an examination of the process of participation. The power of examination can be distributed to different actors as a remedy to possible one-way output.

9.4.5 New insight into actor-network theory from the relationship between older people and health technology

ANT has been under many criticisms by researchers, including the distribution of agency and the undoings of interpretation, society and epistemology (p.26) that have been described in the literature review, so fitting the relationship

between older people and health technology exclusively into the ANT framework would also be circumscribed. In other words, older people's health technology networks can create new insight into the mainstream views of ANT.

Firstly, I recognise an asymmetry in the distribution of power and responsibility in the networks of different stages, which is contrary to the supersymmetry of ANT. At the stage when older people adopt and use health technology, there is a strong interdependence between them and caregivers, which confers significant responsibility and power to the caregivers; but other actors, including technology companies, take these roles of caregivers for granted while reducing their own visibility in the networks. In the case of participation, technology companies in turn hold the power of speech. This situation may be related to the inadequacy of the social policies, for example in Chinese and UK policy documents on the digital health society (National Health Commission, 2022; NHS England, 2022), they emphasise the necessity of digitalisation, acknowledging the possibility of digital exclusion and the scarcity of supportive talent, but are unclear about how to build more supportive systems and how responsibility will be assigned. Actors in the network may also be varied in the extent to which they are driven by the policy.

Secondly, it is obvious that each group of actors is not homogenous, but always has individuality and diversity. For example, older people as adopters have different personalities, adoption behaviours, and ways of interacting with other actors; older people as non-users are composed of different types; and technology companies generate different agencies based on their scale and products. Actors are not always available in networks, which yields a diversity of connections, including successful translation, failed translation, unknown translation, distorted translation and unidirectional output (as shown below, the

lines in other network figures in this chapter can actually be zoomed into this multi-line relationship). We need to be mindful of the profound reasons and issues behind the diversity of actors and translations, such as the implicit social gaps within older people and differences in the level of support from caregivers and technology teams.

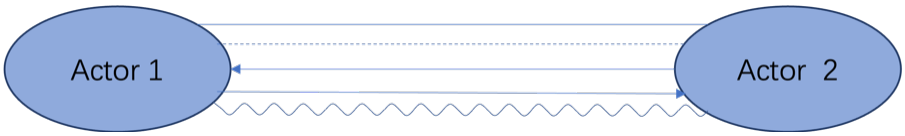

Figure 12: Diverse situations of translation between actors in the network

Thirdly, the position of technology is unfixed in the network. In the case of Louis Pasteur's anthrax vaccine (a classic case of ANT), the non-human actors (microbes) are agents aligned with Pasteur and the "source of strength" (Latour, 1983). In the network of older people and health technology, health technology as the non-human actor, plays its roles in a wider range of positions. Frennert, et al. (2022) depict the mediating role of eHealth from the perspective of healthcare professionals, illustrating how it fosters intimacy between healthcare professionals and patients, mediating augmented knowledge processes, and increasing the autonomy of healthcare professionals. In my research, from the standpoint of older people, health technology acts as an "outcome" in adoption, an "ally with autonomy" in use, an "antagonist of interest" in non-use, and as a "discussion centre to be shaped" in participation. Therefore, technology is always a free element in the network, rather than an object fixed in the network.

This leads to a further discussion of the interests and intentionality of non-human actors, in terms of how the politics and ethics embedded in technology drive its actions. Section 9.3 addresses how health technology shapes different concepts of ageing, the datafication of health and good citizenship, all of which

embody the actions of health technology. Moreover, existing health technologies contain the dominant value of data of technology companies, which gives legitimacy to the organised collection of personal information in health technologies by aiming to aid health research and improve healthcare services (O'Doherty, et al.,2016). However, they also argue that health data collected on a large scale is susceptible to commercialised or harmful secondary use, which is not subject to rigorous ethical scrutiny under existing arrangements. Future health technologies may internalise ethical issues as principles guiding their work, such as how the technology should react when confronted with ethical dilemmas. Stahl, et al. (2014) described a horrific example of this in an imagined technological script – when someone demanded to know "how the family cat worked", the care robot cut the cat open to explain the different organs because the build-in principle of the robot is to have empathy (only) for the human user. Therefore, embedding unexamined ethics in technology to guide actions can be problematic, and there is a need for more stakeholders to work together to keep the interests and intentions of technology within the ethical framework at all times.

Fourthly, there is an ambivalence of relationships and responsibilities within the networks. On the one hand, healthcare professionals and technology companies endeavour to transfer the responsibility for maintaining personal health and positive ageing to older people by getting them to adopt health technologies; on the other hand, healthcare professionals and technology companies sometimes overlook older people's subjective knowledge of technology and their need of help, which leads to the fact that the transfer of responsibility is not well-realised. From this, I identify a crisis of responsibility for care (care for whom) – whether health technology cares for older people or protects healthcare professionals (exempts them from the responsibility). In

Chapter 5, I introduced Lipp's (2023) idea of caring for technology, which certifies the (otherwise unnecessary) effort that older people have to make while caring for themselves. The combination of these two ideas shows that caring may not only for older people, as envisaged by technology workers, but for various actors throughout the network.

Finally, it is noteworthy that the successful formation of a network does not necessarily mean that each actor has independent and powerful agency. In every case of the network, there is a relinquishment or suppression of agency for establishing ostensible stability of the network, such as older people's compromise of using technology and the coercion of technology adoption by policies (Selwyn, 2004; Carlo and Bonifacio, 2020). Therefore, the more explicit socio-technical aim may not be the successful formation of technological networks, but rather the inclusion of older people in a more equal technological society through open and gentle approaches.

Chapter 10: Conclusion

My thesis shows a picture of older people's acceptance of health technology and participation in its development. I find that older people's perceptions of ageing can affect their use of health technology and shape the technology and participation, while health technology produces new orders for the ageing society (e.g., the datafication of health, change of independent identities and relationships). Building on ANT, my thesis also focuses on how various actors (caregivers, technology workers, technology and data, etc.) play a role in the interaction between older people and health technology. Here, the interaction is affected by the materiality of health technology, the interference of caregivers and the collection of health data. By comparing older people in China and the UK, I also identified differences in their adoption of health technology and their perceptions of data privacy and technological participation. I can now provide answers to the four research questions posed in the literature review, extending the main argument and suggesting how they might inspire future research.

For the first research question, I found in Chapter 3, 5 and 6 that health technology can reshape the concepts of ageing and health awareness, leading to possible dependency by replacing older people's autonomy, and creating inequalities based on differences in access and usage patterns. Older people in turn shape health technology by expressing their attitudes, creatively using the technology and participating in the development of health technology. I explained in detail how health technology and the ageing society are co-produced in section 9.3, arguing that older people's conceptualisations of healthy, successful and active ageing produce the demands for or rejection of health technology; while also producing new social orders by facilitating, quantifying, instrumentalising and domesticating healthy ageing, and

objectifying and limiting successful and active ageing (e.g., by threatening the wishes of independence).

The thematic analysis in Chapters 3, 5 and 6 can help me answer the second research question about the factors influencing older people's acceptance of health technology. Drawing on the framework in the literature review, my study confirms the influence of health status (or the need to stay healthy) as a personal factor; usefulness (functionality and effectiveness), ease of use, cost and data considerations as technological factors; and help and the construction of ageing as social factors. I further derive other factors that shape older people's attitudes, including self-esteem, trust in technology (and its platforms), accessories, portability, attitudes to collective interest, stigmatising associations, considerations of space and human work, social policy and cultural factors. There are interconnections between these factors. For example, older people with high self-esteem may be more opposed to the stigmatisation of technology (pp.156-157); some privacy may need to be sacrificed if technology is used for security reasons (p.196). Therefore, older people's acceptance of technology is a complex process. Although modelling and simplifying the process is an illuminating attempt (just as TAM and UTAUT, pp.36-37), the various social components and interrelationships should not be ignored. Older people's considerations also hint at the inequalities brought about by health technology. The complexity of technology, lack of usability, privacy considerations and difficulties in accessing medical resources all lead to gaps within the older population and between older people and other age groups.

Inspired by ANT, I built the networks of older people's acceptance and participation in health technology in section 9.4 and pointed out that the main

human actors in them are older people, caregivers, technology workers, healthcare professionals, and other support groups; the non-human actors include health technology, data, discourses about illness and care, and ageing and technological policies. These actors are intertwined in the networks, where they share interests (e.g., some older people benefit from using health technology, which makes caregivers' jobs easier, and technology companies make money from selling their products), and have conflicts of interest (e.g., older users are worried about privacy disclosure, while technology companies are favour of data collection and establish one-fits-all policy terms that users have to agree with). Besides, the agency of non-human actors is not often addressed in the literature on technology acceptance but inspired by ANT, I have elaborated on the agency of technology, data and policy, which all have interactions of interest with other actors in the networks. For example, the policy about COVID-19 was the actor that initiated the acceptance of the Health Code and attached importance to the collective interest (Cong, 2021).

As I mentioned in the literature review, there is limited knowledge about older people's participation in the development of health technology. I described and compared the attitudes of older people, caregivers and technology workers towards participation in health technology to add to the gap and answer the fourth research question. I argued that older people have an ambivalent attitude towards participation – there are expectations of participation but also doubts about the availability, empowerment, and effectiveness of participation. Caregivers and technology workers have different empowering considerations from older people, revealing the issue of older people's subordinate status in participation and the challenges of integrating RRI into older people's participation (Wilkowska, Brauner and Ziefle, 2018).

In addition, I provided a comparison between older people in China and the UK in the acceptance and participation in health technology and found that their differences related to technological policies, healthcare systems and the democratic nature of the country. For example, Chinese-only use of digital health devices may reflect deficiencies in primary care; Older people in the UK are more concerned about data privacy and have more intention to participate, reflecting the defence of democratic rights.

Looking back at the findings and discussion of my research, I can address some underlying issues and their implications. Deconstructing the elements in the title of the thesis, the first question is, what do older people and the ageing society actually mean? The introduction chapter and the literature review showed that the ageing trend is often perceived as a problem and older people are seen as a burden of care, but I countered this discourse by focusing on the role of the ageing society in actively shaping health technology. Chapter 5 has identified some older people's view of ageing as a progressive rather than declining process, which complements the discourse of the simultaneous development of older people and health technology and demonstrates that older adults have the potential to remain the backbone of society with productivity and creativity.

The next question is, what are the implications of health and health technology about body and data? While discourses about health and illness typically take place in medical situations, my research further depicts older people's struggles between bodily sensations and datafication – with the introduction of health technology, health is not just about the body, it is about data. Sharma, et al. (2018) suggested that data generated by health technology helps to build evidence about health and deliver evidence-based care, but data quality and security are not always guaranteed. To make it further, when health data that

is considered “objective” overrides the “subjective” human feelings, it can trigger a crisis where entities and feelings are completely replaced by data, before the data is adequately protected. In my research, data privacy was discussed by all three groups of interviewees, and the differences in their perceptions reflect both the inequalities of data ownership and the lack of consensus among actors in the technological network regarding data. In other words, health technology and health data are powerful, but their power needs to be subject to consensus and multilateral governance (O’Doherty, et al., 2016).

Then there is the question of the enlightening significance of research on older people’s acceptance and participation in health technology. Previous research on older people’s relationship with health technology tended to view older people’s “lag” as a problem and to encourage technology adoption by older people (e.g., Lee, et al., 2020). From the perspective of active older users and participants, health technology produces protection and extension of bodily functions, and empowerment of citizenship, which endows them with more technological advantages than non-users and non-participants. Most caregivers and technology workers agreed with this idea. However, this superiority may itself entail discrimination against not adopting technology. My thesis further developed the perspective of non-users and non-participants, arguing that while in some cases non-use and non-participation reflect a lack of access, there are also cases where older people actively choose not to use and not to participate based on needs, the downsides of technology and empowerment considerations. In other words, there is no problem with accepting or not accepting technology; what is problematic is segregating users from non-users and segregating people on the path of acceptance or non-acceptance. Therefore, technological equality does not mean that all older people should use and participate in technology, but rather that they have the

choice of whether to use and participate, during which the equality of technology and technological participation is guaranteed, for example by reducing ageism and the formalisation of participation.

In summary, I have provided an account of older people's acceptance and participation in emerging health technologies in China and the UK, which can be a foundation and inspiration for future research. In light of the recognition of older people's agency, the contradictoriness of health technology and the multiple facets of technology acceptance, future research can further explore the agency and power of different groups from their perspectives and refine the goals, guidelines and responsibilities for technology acceptance and participation (e.g., how to balance the data ownership in health technology and who is responsible for problems cause by technology). Considering the geographical and longitudinal system, it may also be worth looking at the situations of Chinese people in the UK and older people in other countries (e.g., Eastern and Western Europeans), the changing attitudes of young and middle-aged people towards technology as they get older (possibly through ethnography), and how this change relates to the context of the times. The better development of the technological society requires ongoing exploration of the relationship between the public and technology.

References

Abbott, S., Fisk, M. and Forward, L., 2000. Social and democratic participation in residential settings for older people: realities and aspirations. *Ageing & Society*, *20*(3), pp.327-340.

Abu-Shanab, E.A., 2011. Education level as a technology adoption moderator. In *2011 3rd International Conference on Computer Research and Development* (Vol. 1, pp. 324-328). IEEE.

Aggarwal, M., Rawat, M.S., Singh, S., Srivastava, S. and Gauba, P., 2017. Generation gap: An emerging issue of society. *International Journal of Engineering Technology Science and Research*, *4*(9), pp.973-983.

Alsyouf, A., Lutfi, A., Alsubahi, N., Alhazmi, F.N., Al-Mugheed, K., Anshasi, R.J., Alharbi, N.I. and Albugami, M., 2023. The use of a Technology Acceptance Model (TAM) to predict patients' usage of a personal health record system: The role of security, privacy, and usability. *International journal of environmental research and public health*, *20*(2), p.1347.

Al-Abbadey, M., Fong, M.M., Wilde, L.J., Ingham, R. and Ghio, D., 2021. Mobile health apps: An exploration of user-generated reviews in Google Play Store on a physical activity application. *Digital Health*, *7*, p.20552076211014988.

Allin, S., Masseria, C. and Mossialos, E., 2006. Inequality in health care use among older people in the United Kingdom: an analysis of panel data. LSE Health.

Anderson M. and Kumar M., 2019. Digital divide persists even as lower-income Americans make gains in tech adoption. Available at: <https://www.pewresearch.org/fact-tank/2019/05/07/digital-divide-persists-even-as-lower-income-americans-make-gains-in-tech-adoption/>

Apple App Store., n.d. The apps you love. From a place you can trust. Available at: <https://www.apple.com/app-store/>

Astell, A.J., McGrath, C. and Dove, E., 2020. 'That's for old so and so's!': does identity influence older adults' technology adoption decisions?. *Ageing & Society*, *40*(7), pp.1550-1576

Arber, S., Vandrevala, T., Daly, T. and Hampson, S., 2008. Understanding gender differences in older people's attitudes towards life-prolonging medical technologies. *Journal of Aging Studies*, *22*(4), pp.366-375.

Atkinson, R. and Flint, J., 2001. Accessing hidden and hard-to-reach populations: Snowball research strategies. *Social research update*, *33*(1), pp.1-4.

AXA PPP, 2015. HEALTH TECH & YOU. Available at: <http://www.2020health.org/dms/2020health/downloads/misc-pdf/151015-State-of-the-Nation-Report-Year-2-Final/151015%20State%20of%20the%20Nation%20Report%20Year%202%20Final.pdf>

Au, Y.A. and Kauffman, R.J., 2008. The economics of mobile payments: Understanding stakeholder issues for an emerging financial technology application. *Electronic Commerce Research and Applications*, *7*(2), pp.141-164.

Bachtiger, P., Adamson, A., Quint, J.K. and Peters, N.S., 2020. Belief of previous COVID-19 infection and unclear government policy are associated with reduced willingness to participate in app-based contact tracing: A UK-wide observational study of 13,000 patients. *MedRxiv*.

Baker, L. and Gringart, E., 2009. Body image and self-esteem in older adulthood. *Ageing & Society*, *29*(6), pp.977-995.

Baker, R., 2001. Bioethics and human rights: A historical perspective. *Cambridge Quarterly of Healthcare Ethics*, *10*(3), pp.241-252.

Balapour, A., Reychav, I., Sabherwal, R. and Azuri, J., 2019. Mobile technology identity and self-efficacy: Implications for the adoption of clinically supported mobile health apps. *International Journal of Information Management*, *49*, pp.58-68.

Baron, L.F. and Gomez, R., 2016. The associations between technologies and societies: the utility of actor-network theory. *Science, Technology and Society*, *21*(2), pp.129-148.

Barony Sanchez, R.H., Bergeron-Drolet, L.A., Sasseville, M. and Gagnon, M.P., 2022. Engaging patients and citizens in digital health technology development through the virtual space. *Frontiers in Medical Technology*, *4*, p.958571.

Barreto, M., Victor, C., Hammond, C., Eccles, A., Richins, M.T. and Qualter, P., 2021. Loneliness around the world: Age, gender, and cultural differences in loneliness. *Personality and individual differences*, *169*, p.110066.

Bauer, M., 2008. Survey research and the public understanding of science. *Handbook of public communication of science and technology*, pp.111-129.

Beard, J.R., Officer, A., De Carvalho, I.A., Sadana, R., Pot, A.M., Michel, J.P., Lloyd-Sherlock, P., Epping-Jordan, J.E., Peeters, G.G., Mahanani, W.R. and Thiyagarajan, J.A., 2016. The World report on ageing and health: a policy framework for healthy ageing. *The lancet*, *387*(10033), pp.2145-2154.

Becker's Hospital Review, 2014. 10 Biggest Technological Advancements for Healthcare in the Last Decade. Available at: <https://www.beckershospitalreview.com/healthcare-information-technology/10-biggest-technological-advancements-for-healthcare-in-the-last-decade.html>

Berauk, V.L.A., Murugiah, M.K., Soh, Y.C., Sheng, Y.C., Wong, T.W. and Ming, L.C., 2018. Mobile health applications for caring of older people: review and comparison. *Therapeutic innovation & regulatory science*, *52*(3), pp.374-382.

Berkowsky, R.W., Sharit, J. and Czaja, S.J., 2017. Factors predicting decisions about technology adoption among older adults. *Innovation in aging*, *1*(3), p.igy002.

Besley, J.C., 2013. The state of public opinion research on attitudes and understanding of science and technology. *Bulletin of Science, Technology & Society*, *33*(1-2), pp.12-20.

Besley, J.C. and Shanahan, J., 2005. Media attention and exposure in relation to support for agricultural biotechnology. *Science Communication*, 26(4), pp.347-367.

Bhatia, R., 2020. Telehealth and COVID-19: Using technology to accelerate the curve on access and quality healthcare for citizens in India. *Technology in Society*, *64*, p.101465.

Bibri, S.E., 2022. The social shaping of the metaverse as an alternative to the imaginaries of data-driven smart Cities: A study in science, technology, and society. *Smart Cities*, *5*(3), pp.832-874.

Bilas, V., Franc, S. and Bošnjak, M., 2014. Determinant factors of life expectancy at birth in the European Union countries. *Collegium antropologicum*, *38*(1), pp.1-9.

Bimber, B., 1990. Karl Marx and the three faces of technological determinism. *Social studies of science*, *20*(2), pp.333-351.

Blank, G., Bolsover, G. and Dubois, E., 2014, August. A new privacy paradox: Young people and privacy on social network sites. In *Prepared for the Annual Meeting of the American Sociological Association* (Vol. 17).

Bogner, A. and Torgersen, H., 2015. Different ways of problematising biotechnology–and what it means for technology governance. *Public Understanding of Science*, *24*(5), pp.516-532.

Bol, N., Helberger, N. and Weert, J.C., 2018. Differences in mobile health app use: a source of new digital inequalities?. *The Information Society*, *34*(3), pp.183-193.

Bordone, V., Arpino, B. and Rosina, A., 2020. Forever young? An analysis of the factors influencing perceptions of ageing. *Ageing & Society*, *40*(8), pp.1669-1693.

Borglin, G., Edberg, A.K. and Hallberg, I.R., 2005. The experience of quality of life among older people. *Journal of aging studies*, *19*(2), pp.201-220.

Boritz, J.E. and No, W.G., 2011. E-commerce and privacy: Exploring what we know and opportunities for future discovery. *Journal of Information Systems*, *25*(2), pp.11-45.

Borji, H.S., 2016. 4 Global Economic Issues of an Aging Population. Available at:<https://www.investopedia.com/articles/investing/011216/4-global-economic-issues-aging-population.asp>

Bostock, Y., Hanley, J., McGown, D., Pinnock, H., Padfield, P. and McKinstry, B., 2009. The acceptability to patients and professionals of remote blood pressure monitoring using mobile phones. *Primary Health Care Research & Development*, *10*(4), pp.299-308.

Bowes, A. and McColgan, G., 2013. Telecare for older people: promoting independence, participation, and identity. *Research on Aging*, *35*(1), pp.32-49.

Bozeman, B., Slade, C.P. and Hirsch, P., 2011. Inequity in the distribution of science and technology outcomes: a conceptual model. *Policy Sciences*, 44(3), pp.231-248.

Braun, V. and Clarke, V., 2012. Thematic analysis. In H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf and K. J. Sher, eds., *APA handbook of research methods in psychology, Vol. 2. Research designs: Quantitative, qualitative, neuropsychological, and biological* (pp. 57–71). American Psychological Association. Ch.4.

Brittain, K., Corner, L., Robinson, L. and Bond, J., 2010. Ageing in place and technologies of place: the lived experience of people with dementia in changing social, physical and technological environments. *Sociology of health & illness*, 32(2), pp.272-287.

Brown, K.E., Hall, A., Hillebrant-Openshaw, M. and Fulton, E.K., 2023. Can an aging leopard change its spots? The role of mindset of aging on implicit and explicit attitudes in older adults. *Research on Aging*, *45*(3-4), pp.291-298.

Brown, R.C., Savulescu, J., Williams, B. and Wilkinson, D., 2020. Passport to freedom? Immunity passports for COVID-19. *Journal of Medical Ethics*, *46*(10), pp.652-659.

Bryce, J. and Klang, M., 2009. Young people, disclosure of personal information and online privacy: Control, choice and consequences. *Information security technical report*, *14*(3), pp.160-166.

Bryman, A., 2016. *Social research methods*. Oxford university press.

Bryson, D., 2015. The adoption and nonadoption of new technologies by the active ageing. In *Textile-Led design for the active ageing population* (pp. 47-58). Woodhead Publishing.

Burr, D.A., Castrellon, J.J., Zald, D.H. and Samanez-Larkin, G.R., 2021. Emotion dynamics across adulthood in everyday life: Older adults are more emotionally stable and better at regulating desires. *Emotion*, *21*(3), p.453.

Cajita, M.I., Hodgson, N.A., Lam, K.W., Yoo, S. and Han, H.R., 2018. Facilitators of and barriers to mHealth adoption in older adults with heart failure. *Computers, informatics, nursing: CIN*, *36*(8), p.376.

Callon, M., 1984. Some elements of a sociology of translation: domestication of the scallops and the fishermen of St Brieuc Bay. *The sociological review*, *32*(1_suppl), pp.196-233.

Callon, M., 1986. The sociology of an actor-network: The case of the electric vehicle. In *Mapping the dynamics of science and technology: Sociology of science in the real world* (pp. 19-34). London: Palgrave Macmillan UK.

Cannizzaro, S., Procter, R., Ma, S. and Maple, C., 2020. Trust in the smart home: Findings from a nationally representative survey in the UK. *Plos one*, *15*(5), p.e0231615.

Carlo, S. and Bonifacio, F., 2020. "You Don't Need Instagram, It's for Young People": Intergenerational Relationships and ICTs Learning Among Older Adults. In *Human Aspects of IT for the Aged Population. Technology and Society: 6th International Conference, ITAP 2020, Held as Part of the 22nd HCI International Conference, HCII 2020, Copenhagen, Denmark, July 19–24, 2020, Proceedings, Part III 22* (pp. 29-41). Springer International Publishing.

Carstensen, L.L., 1995. Evidence for a life-span theory of socioemotional selectivity. *Current directions in Psychological science*, *4*(5), pp.151-156.

Caspi, A., Daniel, M. and Kavé, G., 2019. Technology makes older adults feel older. *Aging & mental health*, *23*(8), pp.1025-1030.

Cattan, M., White, M., Bond, J. and Learmouth, A., 2005. Preventing social isolation and loneliness among older people: a systematic review of health promotion interventions. *Ageing & society*, 25(1), pp.41-67.

Centre for Ageing Better, 2021. Reframing ageing: Public perceptions of ageing, older age and demographic change. Available at: <https://ageing-better.org.uk/sites/default/files/2021-07/Reframing-ageing-public-perceptions.pdf>

Ceruzzi, P.E., 2005. Moore's law and technological determinism: Reflections on the history of technology. *Technology and Culture*, *46*(3), pp.584-593.

Chai, X., 2022. How has the nationwide public health emergency of the COVID-19 pandemic affected older Chinese adults' health literacy, health behaviors and practices, and social connectedness? Qualitative evidence from urban China. *Frontiers in Public Health*, *9*, p.774675.

Chan, N.K., 2021. Anticipatory Futures: Framing the Socio-technical Visions of Online Ratings and Reviews in Wired. *Communication, Culture & Critique*, *14*(2), pp.274-292.

Chao, C.M., 2019. Factors determining the behavioral intention to use mobile learning: An application and extension of the UTAUT model. *Frontiers in psychology*, *10*, p.1652.

Chen, C. and Liu, M., 2023. Achievements and Challenges of the Healthcare System in China. *Cureus*, *15*(5).

Chen, K., 2020. Why do older people love and hate assistive technology?–an emotional experience perspective. *Ergonomics*, *63*(12), pp.1463-1474.

Chen, K. and Chan, A.H.S., 2014. Gerontechnology acceptance by elderly Hong Kong Chinese: a senior technology acceptance model (STAM). *Ergonomics*, *57*(5), pp.635-652.

Chen, M., 1986. Gender and computers: The beneficial effects of experience on attitudes. *Journal of educational computing research*, *2*(3), pp.265-282.

Cheng, S.T. and Chan, A.C., 2006. Filial piety and psychological well-being in well older Chinese. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *61*(5), pp.P262-P269.

Chidambaram, S., Erridge, S., Kinross, J. and Purkayastha, S., 2020. Observational study of UK mobile health apps for COVID-19. *The Lancet Digital Health*, *2*(8), pp.e388-e390.

China Association of Social Security, 2022. Research report on ageing in China. Available at: <https://www.caoss.org.cn/UploadFile/pic/20229281791192316.pdf>

Choi, N.G. and DiNitto, D.M., 2013. The digital divide among low-income homebound older adults: Internet use patterns, eHealth literacy, and attitudes toward computer/Internet use. *Journal of medical Internet research*, *15*(5), p.e93.

Christie, G., 2018. Progressing the health agenda: responsibly innovating in health technology. *Journal of Responsible Innovation*, *5*(1), pp.143-148.

Chu, L., Chen, H.W., Cheng, P.Y., Ho, P., Weng, I.T., Yang, P.L., Chien, S.E., Tu, Y.C., Yang, C.C., Wang, T.M. and Fung, H.H., 2019. Identifying features that enhance older adults' acceptance of robots: a mixed methods study. *Gerontology*, *65*(4), pp.441-450.

Cimperman, M., Brenčič, M.M., Trkman, P. and Stanonik, M.D.L., 2013. Older adults' perceptions of home telehealth services. *Telemedicine and e-Health*, *19*(10), pp.786-790.

Clark, J. and McGee-Lennon, M., 2011. A stakeholder-centred exploration of the current barriers to the uptake of home care technology in the UK. *Journal of Assistive Technologies*.

Clark, N., 2020. What can go wrong when people become interested in the nonhuman. In: A. Blok, I. Farías and C. Roberts, eds. 2020. *The Routledge companion to actor-network theory*, Taylor & Francis, pp.158-167.

CNNIC, 2021. The 47th China Statistical Report on Internet Development. Available at: <https://www.gov.cn/xinwen/2021-02/03/5584518/files/bd16adb558714132a829f43915bc1c9e.pdf>

Coleman, G.W., Gibson, L., Hanson, V.L., Bobrowicz, A. and McKay, A., 2010, August. Engaging the disengaged: How do we design technology for digitally excluded older adults?. In *Proceedings of the 8th ACM Conference on Designing Interactive Systems* (pp. 175-178).

Colgan, M., 2019. How important are mobile app ratings & reviews? Available at: <https://tapadoo.com/mobile-app-ratings-reviews/>

Compagna, D. and Kohlbacher, F., 2015. The limits of participatory technology development: The case of service robots in care facilities for older people. *Technological forecasting and social change*, *93*, pp.19-31.

Cong, W., 2021. From pandemic control to data-driven governance: The case of China's health code. *Frontiers in Political Science*, *3*, p.627959.

Conroy, K.M., Krishnan, S., Mittelstaedt, S. and Patel, S.S., 2020. Technological advancements to address elderly loneliness: Practical considerations and community resilience implications for COVID-19 pandemic. *Working with Older People*, *24*(4), pp.257-264.

Copcu, M., Salman, Y.B. and Cheng, H.I., 2011, October. Turkish senior's perspective and utilization of mobile phones. In *The 5th International*

Conference on New Trends in Information Science and Service Science (Vol. 1, pp. 146-150). IEEE

Cresswell, K.M., Worth, A. and Sheikh, A., 2010. Actor-Network Theory and its role in understanding the implementation of information technology developments in healthcare. *BMC medical informatics and decision making*, *10*(1), pp.1-11.

Cruz-Cárdenas, J., Zabelina, E., Deyneka, O., Guadalupe-Lanas, J. and Velín-Fárez, M., 2019. Role of demographic factors, attitudes toward technology, and cultural values in the prediction of technology-based consumer behaviors: A study in developing and emerging countries. *Technological Forecasting and Social Change*, *149*, p.119768

Csibi, S., Griffiths, M.D., Demetrovics, Z. and Szabo, A., 2021. Analysis of problematic smartphone use across different age groups within the 'components model of addiction'. *International Journal of Mental Health and Addiction*, *19*(3), pp.616-631.

Cuddy, A.J., Norton, M.I. and Fiske, S.T., 2005. This old stereotype: The pervasiveness and persistence of the elderly stereotype. *Journal of social issues*, *61*(2), pp.267-285.

Czaja, S., Beach, S., Charness, N. and Schulz, R., 2013. Older adults and the adoption of healthcare technology: Opportunities and challenges. *Technologies for active aging*, pp.27-46.

Czaja, S.J., Charness, N., Fisk, A.D., Hertzog, C., Nair, S.N., Rogers, W.A. and Sharit, J., 2006. Factors predicting the use of technology: findings from the Center for Research and Education on Aging and Technology Enhancement (CREATE). *Psychology and aging*, *21*(2), p.333.

D'Angelo, S., Bloom, I., Ntani, G. and Walker-Bone, K., 2024. Why did middle-aged and older people retire since the first COVID-19 lockdown? A qualitative

study of participants from the Health and Employment After Fifty study. *BMC Public Health*, *24*(1), p.103

Davis, F.D., 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, pp.319-340.

De la Harpe, R., 2014. The level of participation during the development of a mobile application for home-based healthcare data in a developing context: An actor-network theory perspective. *South African Computer Journal*, *54*(si-2), pp.20-33.

De Loureiro, P.M., Horta, H. and Santos, J.M., 2021. Mapping case studies of public engagement and participation in science and technology. *Science & Technology Studies*, 34(2), pp.46-64.

Demers-Payette, O., Lehoux, P. and Daudelin, G., 2016. Responsible research and innovation: a productive model for the future of medical innovation. *Journal of Responsible Innovation*, *3*(3), pp.188-208

Deng, B. and Sun, Z., 2021. Free medical check-ups for the rural elderly have been implemented for several years and the response has been mediocre. Available at: <https://www.thepaper.cn/newsDetail_forward_14548131>

Depp, C.A. and Jeste, D.V., 2006. Definitions and predictors of successful aging: a comprehensive review of larger quantitative studies. *The American Journal of Geriatric Psychiatry*, *14*(1), pp.6-20.

Dequanter, S., Fobelets, M., Steenhout, I., Gagnon, M.P., Bourbonnais, A., Rahimi, S., Buyl, R. and Gorus, E., 2022. Determinants of technology adoption and continued use among cognitively impaired older adults: a qualitative study. *BMC geriatrics*, *22*(1), pp.1-16.

Dermody, G., Fritz, R., Glass, C., Dunham, M. and Whitehead, L., 2021. Factors influencing community-dwelling older adults' readiness to adopt smart

home technology: A qualitative exploratory study. *Journal of Advanced Nursing*, *77*(12), pp.4847-4861.

Dong, W. 2006. Currently only 22.5 per cent people are willing to go to community hospitals. Available at: <http://zqb.cyol.com/content/2006-11/13/content_1571071.htm>

Doss, C.R. and Morris, M.L., 2000. How does gender affect the adoption of agricultural innovations? The case of improved maize technology in Ghana. *Agricultural economics*, *25*(1), pp.27-39.

Dowthwaite, L., Wagner, H.G., Babbage, C.M., Fischer, J.E., Barnard, P., Nichele, E., Perez Vallejos, E., Clos, J., Portillo, V. and McAuley, D., 2022. The relationship between trust and attitudes towards the COVID-19 digital contact-tracing app in the UK. *PLoS One*, *17*(10), p.e0276661.

Dragu, T. and Lupu, Y., 2021. Digital authoritarianism and the future of human rights. *International Organization*, *75*(4), pp.991-1017.

Drenth-van Maanen, A.C., Wilting, I. and Jansen, P.A., 2020. Prescribing medicines to older people—How to consider the impact of ageing on human organ and body functions. *British journal of clinical pharmacology*, *86*(10), pp.1921-1930.

Drury, J., Mao, G., John, A., Kamal, A., Rubin, G.J., Stott, C., Vandrevala, T. and Marteau, T.M., 2021. Behavioural responses to Covid-19 health certification: a rapid review. *BMC Public Health*, *21*(1), p.1205.

Durant, J.R., Evans, G.A. and Thomas, G.P., 1989. The public understanding of science. *Nature*, *340*(6228), pp.11-14.

Edison, S.W. and Geissler, G.L., 2003. Measuring attitudes towards general technology: Antecedents, hypotheses and scale development. *Journal of targeting, Measurement and Analysis for Marketing*, *12*(2), pp.137-156.

Eisma, R., Dickinson, A., Goodman, J., Mival, O., Syme, A. and Tiwari, L., 2003. Mutual inspiration in the development of new technology for older people. *Proceedings of Include*.

Elmustapha, H., Hoppe, T. and Bressers, H., 2018. Understanding stakeholders' views and the influence of the socio-cultural dimension on the adoption of solar energy technology in Lebanon. *Sustainability*, *10*(2), p.364.

Elo, S., Kääriäinen, M., Kanste, O., Pölkki, T., Utriainen, K. and Kyngäs, H., 2014. Qualitative content analysis: A focus on trustworthiness. *SAGE open*, *4*(1), p.2158244014522633.

Erikson, E. H., 1995. *Childhood and society*. London: Vintage.

Eubanks, V., 2007. Popular technology: Exploring inequality in the information economy. *Science and Public Policy*, *34*(2), pp.127-138.

Eubanks, V., 2018. *Automating inequality: How high-tech tools profile, police, and punish the poor*. St. Martin's Press.

Eubanks, V.E., 2007. Trapped in the digital divide: The distributive paradigm in community informatics. *The Journal of Community Informatics*, *3*(2).

Feng, Y. and Agosto, D.E., 2017. The experience of mobile information overload: struggling between needs and constraints.

Fischer, B., Peine, A. and Östlund, B., 2020. The importance of user involvement: a systematic review of involving older users in technology design. *The Gerontologist*, *60*(7), pp.e513-e523

Foster, L., 2018. Active ageing, pensions and retirement in the UK. *Journal of population ageing*, *11*, pp.117-132.

Foster, L. and Walker, A., 2015. Active and successful aging: A European policy perspective. *The gerontologist*, *55*(1), pp.83-90.

Fotteler, M., Risch, B., Gaugisch, P., Furmanek, J.L., Swoboda, W., Mayer, S., Kohn, B., Dallmeier, D. and Denkinger, M., 2021. Obstacles to using assistive technology for older adults–results from a focus group analysis. In *Public Health and Informatics* (pp. 994-998). IOS Press.

Fox, G. and Connolly, R., 2018. Mobile health technology adoption across generations: Narrowing the digital divide. *Information Systems Journal*, *28*(6), pp.995-1019.

Frennert, S., Petersson, L., Muhic, M., Rydenfält, C., Nymberg, V.M., Ekman, B. and Erlingsdottir, G., 2022. Materiality and the mediating roles of eHealth: A qualitative study and comparison of three cases. *Digital health*, *8*, pp.1-14.

Friemel, T.N., 2016. The digital divide has grown old: Determinants of a digital divide among seniors. *New media & society*, *18*(2), pp.313-331.

Fu, T., 2019. China's personal information protection in a data-driven economy: A privacy policy study of Alibaba, Baidu and Tencent. *Global Media and Communication*, *15*(2), pp.195-213.

Gao, C., Zhou, L., Liu, Z., Wang, H. and Bowers, B., 2017. Mobile application for diabetes self-management in China: Do they fit for older adults?. *International journal of medical informatics*, *101*, pp.68-74.

Gao, L., Liao, M. and Zhao, Y., 2019. Exploring complexity, variety and the necessity of RRI in a developing country: the case of China. *Journal of Responsible Innovation*, *6*(3), pp.368-374.

Garvey, P. and Miller, D., 2021. *Ageing with Smartphones in Ireland: When life becomes craft*. UCL Press.

Gaskell, G., Allum, N., Bauer, M., Durant, J., Allansdottir, A., Bonfadelli, H., Boy, D., De Cheveigné, S., Fjaestad, B., Gutteling, J.M. and Hampel, J., 2000. Biotechnology and the European public. *Nature biotechnology*, *18*(9), pp.935-938.

Genc-Nayebi, N. and Abran, A., 2017. A systematic literature review: Opinion mining studies from mobile app store user reviews. *Journal of Systems and Software*, *125*, pp.207-219.

Giovanis, A.N., Binioris, S. and Polychronopoulos, G., 2012. An extension of TAM model with IDT and security/privacy risk in the adoption of internet banking services in Greece. *EuroMed Journal of Business*, *7*(1), pp.24-53.

Golant, S.M., 2017. A theoretical model to explain the smart technology adoption behaviors of elder consumers (Elderadopt). *Journal of Aging Studies*, *42*, pp.56-73.

Goodyear, V.A. and Armour, K.M., 2018. Young people's perspectives on and experiences of health-related social media, apps, and wearable health devices. *Social Sciences*, *7*(8), p.137.

Göransson, B. and Rolfstam, M., 2013. Development and use of gender-specific technologies: evidence from China, Poland, and Sweden. *Gender, Technology and Development*, *17*(3), pp.281-312.

Gordon, N.P. and Hornbrook, M.C., 2016. Differences in access to and preferences for using patient portals and other eHealth technologies based on race, ethnicity, and age: a database and survey study of seniors in a large health plan. *Journal of medical Internet research*, *18*(3), p.e50.

Greenhalgh, T., Wherton, J., Sugarhood, P., Hinder, S., Procter, R. and Stones, R., 2013. What matters to older people with assisted living needs? A phenomenological analysis of the use and non-use of telehealth and telecare. *Social science & medicine*, *93*, pp.86-94.

Gregory, J. and Lock, S.J., 2008. The evolution of 'public understanding of science': Public engagement as a tool of science policy in the UK. *Sociology Compass*, *2*(4), pp.1252-1265.

Grosios, K., Gahan, P.B. and Burbidge, J., 2010. Overview of healthcare in the UK. *EPMA journal*, *1*, pp.529-534.

Guan, T. and Chen, X., 2023. The emerging scientific public sphere in China's digital economy: Weibo discussions on facial recognition technology. *Public Understanding of Science*, *32*(2), pp.208-223.

Gurzawska, A., Mäkinen, M. and Brey, P., 2017. Implementation of Responsible Research and Innovation (RRI) practices in industry: Providing the right incentives. *Sustainability*, *9*(10), p.1759

Guzman, E., Oliveira, L., Steiner, Y., Wagner, L.C. and Glinz, M., 2018, May. User feedback in the app store: a cross-cultural study. In *2018 IEEE/ACM 40th International Conference on Software Engineering: Software Engineering in Society (ICSE-SEIS)* (pp. 13-22). IEEE.

Hakkarainen, S., 2013. Expectations and User Experiences as Determinants of Technology Adoption and Continued Use.

Hämäläinen, A. and Hirvonen, H., 2020. Electronic Health Records reshaping the socio-technical practices in Long-Term Care of older persons. *Technology in Society*, 62, p.101316.

Hanafizadeh, P., Behboudi, M., Koshksaray, A.A. and Tabar, M.J.S., 2014. Mobile-banking adoption by Iranian bank clients. *Telematics and Informatics*, *31*(1), pp.62-78.

Hannigan, B. and Allen, D., 2006. Complexity and change in the United Kingdom's system of mental health care. *Social Theory & Health*, *4*, pp.244-263.

Hanson, V.L., 2010. Influencing technology adoption by older adults. *Interacting with Computers*, 22(6), pp.502-509.

Hardcastle, S. and Taylor, A.H., 2005. Finding an exercise identity in an older body:"It's redefining yourself and working out who you are". *Psychology of sport and exercise*, *6*(2), pp.173-188.

Hauk, N., Hüffmeier, J. and Krumm, S., 2018. Ready to be a silver surfer? A meta-analysis on the relationship between chronological age and technology acceptance. *Computers in Human Behavior*, *84*, pp.304-319.

Hawthorn, D., 2007. Interface design and engagement with older people. *Behaviour & Information Technology*, *26*(4), pp.333-341.

He, W., Zhang, C. and Gao, H., 2008. Chinese Public Understanding of Science and Attitudes towards Science and Technology, 2007. *Studies on Science Popularization*, *3*(6), pp.8-37.

He, W., Zhang, C., Ren, L. and Huang, L., 2018. Public Attitudes towards and Understanding of Science and Technology in China: Based on the Results of Civic Scientific Literacy Survey 2018. *Studies on Science Popularization*, *13*(6), pp.49-58+65.

Heart, T. and Kalderon, E., 2013. Older adults: are they ready to adopt health-related ICT?. *International journal of medical informatics*, *82*(11), pp.e209-e231.

Heilbroner, R.L., 1967. Do machines make history?. *Technology and culture*, *8*(3), pp.335-345.

Heilbroner, R., 1994. Technological determinism revisited. *Does technology drive history*, *1*, pp.67-78.

Helbostad, J.L., Vereijken, B., Becker, C., Todd, C., Taraldsen, K., Pijnappels, M., Aminian, K. and Mellone, S., 2017. Mobile health applications to promote active and healthy ageing. *Sensors*, *17*(3), p.622.

Henwood, F. and Marent, B., 2019. Understanding digital health: Productive tensions at the intersection of sociology of health and science and technology studies. *Sociology of health & illness*, *41*, pp.1-15.

Heu, L.C., van Zomeren, M. and Hansen, N., 2019. Lonely alone or lonely together? A cultural-psychological examination of individualism–collectivism and loneliness in five European countries. *Personality and Social Psychology Bulletin*, *45*(5), pp.780-793.

Hirst, Y., Stoffel, S.T., Brewer, H.R., Timotijevic, L., Raats, M.M. and Flanagan, J.M., 2023. Understanding Public Attitudes and Willingness to Share Commercial Data for Health Research: Survey Study in the United Kingdom. *JMIR Public Health and Surveillance*, *9*(1), p.e40814.

Ho, S.S., Brossard, D. and Scheufele, D.A., 2008. Effects of value predispositions, mass media use, and knowledge on public attitudes toward embryonic stem cell research. *International Journal of Public Opinion Research*, 20(2), pp.171-192.

Hong, S.I., 2016. Community older adults' attitude towards the use of assistive devices. *Asia Pacific Journal of Social Work and Development*, *26*(4), pp.217-230.

Hoofnagle, C.J., Van Der Sloot, B. and Borgesius, F.Z., 2019. The European Union general data protection regulation: what it is and what it means. *Information & Communications Technology Law*, *28*(1), pp.65-98.

Hötte, K., Somers, M. and Theodorakopoulos, A., 2023. Technology and jobs: A systematic literature review. *Technological Forecasting and Social Change*, *194*, p.122750.

House of Lords Select Committee on Science and Technology. 2000. *Science and Society*. London: HMSO.

Hsieh, H.F. and Shannon, S.E., 2005. Three approaches to qualitative content analysis. *Qualitative health research*, *15*(9), pp.1277-1288.

Hu, A. and Zhou, S., 2002. A new global gap between the rich and the poor: The increasingly widening “Digital Gap”. *Soc. Sci. China*, 3, pp.34-48.

Ienca, M., Schneble, C., Kressig, R.W. and Wangmo, T., 2021. Digital health interventions for healthy ageing: a qualitative user evaluation and ethical assessment. *BMC geriatrics*, *21*, pp.1-10

Ilhan, A. and Fietkiewicz, K.J., 2021. Data privacy-related behavior and concerns of activity tracking technology users from Germany and the USA. *Aslib Journal of Information Management*, *73*(2), pp.180-200.

Ince Yenilmez, M., 2015. Economic and social consequences of population aging the dilemmas and opportunities in the twenty-first century. *Applied Research in Quality of Life*, *10*(4), pp.735-752.

Jasanoff, S., 2016. *The ethics of invention: Technology and the human future*. WW Norton & Company.

Jasanoff, S. and Kim, S.H., 2009. Containing the atom: Sociotechnical imaginaries and nuclear power in the United States and South Korea. *Minerva*, *47*, pp.119-146.

Jasanoff, S. and Simmet, H.R., 2017. No funeral bells: Public reason in a ‘post-truth’ age. *Social studies of science*, *47*(5), pp.751-770.

Jasanoff, S. ed., 2004. *States of knowledge: the co-production of science and the social order*. Routledge.

Jaschinski, C., Ben Allouch, S., Peters, O. and van Dijk, J., 2020. The influence of privacy on the acceptance of technologies for assisted living. In *Human Aspects of IT for the Aged Population. Healthy and Active Aging: 6th International Conference, ITAP 2020, Held as Part of the 22nd HCI International Conference, HCII 2020, Copenhagen, Denmark, July 19–24, 2020, Proceedings, Part II 22* (pp. 463-473). Springer International Publishing.

Jefferies, P. and Ungar, M., 2020. Social anxiety in young people: A prevalence study in seven countries. *PloS one*, *15*(9), p.e0239133.

Jefferson, R., 2019. More seniors are embracing technology. But can they use it? UCSD researchers suggest asking them. Available at: <https://www.forbes.com/sites/robinseatonjefferson/2019/06/28/more-seniors-are-embracing-technology-but-can-they-use-it-ucsd-researchers-suggest-asking-them/?sh=3d6596242323>

Jeng, M.Y., Pai, F.Y. and Yeh, T.M., 2022. Antecedents for older adults' intention to use smart health wearable devices-technology anxiety as a moderator. *Behavioral Sciences*, *12*(4), p.114.

Jha, N. and Mahmoud, A., 2017. Mining user requirements from application store reviews using frame semantics. In *International working conference on requirements engineering: Foundation for software quality* (pp. 273-287). Springer, Cham.

Jha, N. and Mahmoud, A., 2019. Mining non-functional requirements from app store reviews. *Empirical Software Engineering*, *24*(6), pp.3659-3695.

Jia, H., 2022. More engagement but less participation: China's alternative approach to public communication of science and technology. *Public Understanding of Science*, *31*(3), pp.331-339.

Jia, H. and Liu, L., 2014. Unbalanced progress: The hard road from science popularisation to public engagement with science in China. *Public Understanding of Science*, *23*(1), pp.32-37.

Jiang, Y., Sun, P., Chen, Z., Guo, J., Wang, S., Liu, F. and Li, J., 2022. Patients' and healthcare providers' perceptions and experiences of telehealth use and online health information use in chronic disease management for older patients with chronic obstructive pulmonary disease: a qualitative study. *BMC geriatrics*, *22*, pp.1-16.

Jo, H.S. and Hwang, Y.S., 2021. Psychological factors that affect the acceptance and need for ICT services for older adults with chronic diseases. *Gerontechnology*, *20*(2).

Jones, S.E., 2013. *Against technology: From the Luddites to neo-Luddism*. Routledge.

Joyce, K. and Loe, M., 2010. A sociological approach to ageing, technology and health. *Sociology of health & illness*, *32*(2), pp.171-180.

Kamin, S.T., Beyer, A. and Lang, F.R., 2020. Social support is associated with technology use in old age. *Zeitschrift für Gerontologie und Geriatrie*, *53*(3), pp.256-262.

Kaplan, B., 2016. How should health data be used?: Privacy, secondary use, and big data sales. *Cambridge Quarterly of Healthcare Ethics*, *25*(2), pp.312-329.

Karliner, L., 2022. Increasing telehealth access for older adults during pandemic. Available at:

<https://www.jointcommission.org/resources/news-and-multimedia/blogs/improvement-insights/2022/03/increasing-telehealth-access-for-older-adults-during-pandemic/>

Khosravi, P. and Ghapanchi, A.H., 2016. Investigating the effectiveness of technologies applied to assist seniors: A systematic literature review. *International journal of medical informatics*, *85*(1), pp.17-26

Kim, J., Lee, H.Y., Christensen, M.C. and Merighi, J.R., 2017. Technology access and use, and their associations with social engagement among older adults: Do women and men differ?. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *72*(5), pp.836-845.

Kim, S. and Choudhury, A., 2020. Comparison of older and younger adults' attitudes toward the adoption and use of activity trackers. *JMIR mHealth and uHealth*, *8*(10), p.e18312.

Kim, S., Gajos, K.Z., Muller, M. and Grosz, B.J., 2016. Acceptance of mobile technology by older adults: a preliminary study. In *Proceedings of the 18th international conference on human-computer interaction with mobile devices and services* (pp.147-157).

Kivits, J., 2013. E-health and renewed sociological approaches to health and illness. In *Digital sociology: Critical perspectives* (pp. 213-226). London: Palgrave Macmillan UK.

Klaver, N.S., Van de Klundert, J. and Askari, M., 2021. Relationship between perceived risks of using mHealth applications and the intention to use them among older adults in the Netherlands: cross-sectional study. *JMIR mHealth and uHealth*, *9*(8), p.e26845

Kolstad, A. and Gjesvik, N., 2014. Collectivism, individualism, and pragmatism in China: Implications for perceptions of mental health. *Transcultural psychiatry*, *51*(2), pp.264-285.

Kotze, T.G., Anderson, O. and Summerfield, K., 2016. Technophobia: Gender differences in the adoption of high-technology consumer products. *South African Journal of Business Management*, *47*(1), pp.21-28.

Krabbenborg, L. and Mulder, H.A., 2015. Upstream public engagement in nanotechnology: constraints and opportunities. *Science Communication*, *37*(4), pp.452-484.

Kumar, G., Engle, C. and Tucker, C., 2018. Factors driving aquaculture technology adoption. *Journal of the world aquaculture society*, 49(3), pp.447-476.

Kvale, S., 2008. *Doing interviews*. Sage.

Lacsa, J.E.M., 2021. COVID-19 vaccine passports: a mandatory choice or a mere option?. *Journal of Public Health*.

Laidlaw, K., Wang, D., Coelho, C. and Power, M., 2010. Attitudes to ageing and expectations for filial piety across Chinese and British cultures: A pilot exploratory evaluation. *Aging & Mental Health*, *14*(3), pp.283-292.

Latour, B., 1983. Give me a laboratory and I will raise the world. *Science observed: Perspectives on the social study of science*, pp.141-170.

Latour, B., 1987. *Science in action: How to follow scientists and engineers through society*. Harvard university press.

Latour, B., 2007. *Reassembling the social: An introduction to actor-network-theory*. Oup Oxford.

Law, J., 1999. After ANT: complexity, naming and topology. *The sociological review*, *47*(1_suppl), pp.1-14.

Law, J., 2008. Actor network theory and material semiotics. *The new Blackwell companion to social theory*, pp.141-158.

Law, J., 2010. The materials of STS. In: D. Hicks, and M. C. Beaudry, eds. 2010. *The Oxford Handbook of Material Culture Studies*. Oxford Academic, pp. 173-188.

Lazaro, M.J.S., Lim, J., Kim, S.H. and Yun, M.H., 2020. Wearable technologies: acceptance model for smartwatch adoption among older adults. In *Human Aspects of IT for the Aged Population. Technologies, Design and User Experience: 6th International Conference, ITAP 2020, Held as Part of the 22nd HCI International Conference, HCII 2020, Copenhagen, Denmark, July 19–24, 2020, Proceedings, Part I 22* (pp. 303-315). Springer International Publishing.

Lee, C. and Coughlin, J.F., 2015. PERSPECTIVE: Older adults' adoption of technology: an integrated approach to identifying determinants and barriers. *Journal of Product Innovation Management*, *32*(5), pp.747-759.

Lee, M., Kang, D., Yoon, J., Shim, S., Kim, I.R., Oh, D., Shin, S.Y., Hesse, B.W. and Cho, J., 2020. The difference in knowledge and attitudes of using mobile health applications between actual user and non-user among adults aged 50 and older. *PLoS One*, *15*(10), p.e0241350.

Lee, S.G., Trimi, S. and Kim, C., 2013. The impact of cultural differences on technology adoption. *Journal of world business*, *48*(1), pp.20-29.

Légaré, J., 2015. Population Aging: Economic and Social Consequences. In *International Encyclopedia of the Social & Behavioral Sciences (Second Edition)* (pp. 540-544). https://doi.org/10.1016/B978-0-08-097086-8.34041-7

Legris, P., Ingham, J. and Collerette, P., 2003. Why do people use information technology? A critical review of the technology acceptance model. *Information & management*, 40(3), pp.191-204.

Leino-Kilpi, H., Välimäki, M., Dassen, T., Gasull, M., Lemonidou, C., Scott, A. and Arndt, M., 2001. Privacy: a review of the literature. *International journal of nursing studies*, *38*(6), pp.663-671.

Leswing, K., 2019. Inside Apple's team that greenlights iPhone apps for the App Store. Avaiable at: <https://www.cnbc.com/2019/06/21/how-apples-app-review-process-for-the-app-store-works.html>

Li, B., 2020. Digital feedback and group pressure: a study on the influencing factors of WeChat Moments in the elderly. *Chinese Journal of Journalism and Communication*, 42(3), pp.32-48.

Li, J., Ma, Q., Chan, A.H. and Man, S., 2019. Health monitoring through wearable technologies for older adults: Smart wearables acceptance model. *Applied ergonomics*, *75*, pp.162-169

Li, N. and Kirkup, G., 2007. Gender and cultural differences in Internet use: A study of China and the UK. *Computers & Education*, *48*(2), pp.301-317.

Li, S., Glass, R. and Records, H., 2008. The influence of gender on new technology adoption and use–mobile commerce. *Journal of Internet Commerce*, 7(2), pp.270-289.

Li, W., Gui, J., Luo, X., Yang, J., Zhang, T. and Tang, Q., 2023. Determinants of intention with remote health management service among urban older adults: A Unified Theory of Acceptance and Use of Technology perspective. *Frontiers in Public Health*, *11*, p.1117518.

Liang, F., 2020. <? covid19?> COVID-19 and Health Code: How Digital Platforms Tackle the Pandemic in China. *Social Media+ Society*, *6*(3), p.2056305120947657.

Lidynia, C., Schomakers, E.M. and Ziefle, M., 2019. What are you waiting for?–perceived barriers to the adoption of fitness-applications and wearables.

In *Advances in Human Factors in Wearable Technologies and Game Design: Proceedings of the AHFE 2018 International Conferences on Human Factors and Wearable Technologies, and Human Factors in Game Design and Virtual Environments* (pp. 41-52). Springer International Publishing.

Lie, M.L., Lindsay, S. and Brittain, K., 2016. Technology and trust: older people's perspectives of a home monitoring system. *Ageing & Society*, *36*(7), pp.1501-1525.

Lievrouw, L.A., 2006. New media design and development: Diffusion of innovations v social shaping of technology. *The handbook of new media*, pp.246-265.

Lievrouw, L.A., 2014. Materiality and media in communication and technology studies: An unfinished project. In: T. Gillespie, P.J. Boczkowski and K.A. Foot, ed. 2014. *Media technologies: Essays on communication, materiality, and society*. MIT Press, pp.21-51.

Lin, G. and Wu, C., 2024. Crafting “Identity”: Mutual Recognition of Politeness in Consumer Interaction on E-commerce Platforms. *Media Observer*, *3*, pp.94-101.

Lin, K., Ning, Y., Mumtaz, A. and Li, H., 2022. Exploring the relationships between four aging ideals: a bibliometric study. *Frontiers in Public Health*, *9*, p.762591.

Lindeman, D. 2012. Emerging Technologies for Our Aging Society. Available at: <https://www.asaging.org/blog/emerging-technologies-our-aging-society>

Lipp, B., 2023. Caring for robots: How care comes to matter in human-machine interfacing. *Social Studies of Science*, *53*(5), pp.660-685.

Lipp, B. and Peine, A., 2022. Ageing as a driver of progressive politics? What the European Silver Economy teaches us about the co-constitution of ageing and innovation. *Ageing & Society*, pp.1-13.

Liu, C., 2022. Seeing like a state, enacting like an algorithm: (Re)assembling contact tracing and risk assessment during the COVID-19 pandemic. *Science, Technology, & Human Values*, *47*(4), pp.698-725.

Liu, J., Ma, H., He, Y.L., Xie, B., Xu, Y.F., Tang, H.Y., Li, M., Hao, W., Wang, X.D., Zhang, M.Y. and Ng, C.H., 2011. Mental health system in China: history, recent service reform and future challenges. *World psychiatry*, *10*(3), p.210.

Liu, L., Wu, F., Tong, H., Hao, C. and Xie, T., 2021. The digital divide and active aging in China. *International journal of environmental research and public health*, *18*(23), p.12675.

Liu, M.B., Dufour, G., Sun, Z.E., Galante, J., Xing, C.Q., Zhan, J.Y. and Wu, L.L., 2021. The impact of the COVID-19 pandemic on the mental health of young people: A comparison between China and the United Kingdom. *Chinese Journal of Traumatology*, *24*(04), pp.231-236.

Liu, X., Tang, S. and Bauer, M.W., 2012. Comparing the public understanding of science across China and Europe. In *The Culture of Science* (pp. 139-157). Routledge.

Liu, X., Ye, Q., Li, Y., Fan, J. and Tao, Y., 2021. Examining public concerns and attitudes toward unfair events involving elderly travelers during the COVID-19 pandemic using Weibo data. *International Journal of Environmental Research and Public Health*, *18*(4), p.1756.

Loe, M., 2010. Doing it my way: old women, technology and wellbeing. *Sociology of health & illness*, 32(2), pp.319-334.

López-Gómez, D., 2019. What if ANT wouldn't pursue agnosticism but care?. In *The Routledge companion to actor-network theory* (pp. 4-13). Routledge.

Loretto, W., Lain, D. and Vickerstaff, S., 2013. Rethinking retirement: changing realities for older workers and employee relations?. *Employee Relations*, *35*(3).

Low, S.T.H., Govind, S.P., Lai, Y.F., Long, A.D.S. and Kaur-Gill, S., 2021. Attitudes and Perceptions towards Healthcare Technology Adoption among Older Adults in Singapore: A Qualitative Study. *Frontiers in public health*, *9*, p.74.

Lu, L., Kao, S.F. and Hsieh, Y.H., 2010. Positive attitudes toward older people and well-being among Chinese community older adults. *Journal of Applied Gerontology*, *29*(5), pp.622-639.

Lü, Y. 2005. Privacy and data privacy issues in contemporary China. *Ethics and Information Technology*, *7*, pp.7-15.

Luchenski, S.A., Reed, J.E., Marston, C., Papoutsi, C., Majeed, A. and Bell, D., 2013. Patient and public views on electronic health records and their uses in the United Kingdom: cross-sectional survey. *Journal of medical Internet research*, *15*(8), p.e160.

Luijkx, K., Peek, S. and Wouters, E., 2015. "Grandma, you should do it—It's cool" Older Adults and the Role of Family Members in Their Acceptance of Technology. *International journal of environmental research and public health*, *12*(12), pp.15470-15485.

Lupton, D., 2013. The digitally engaged patient: Self-monitoring and self-care in the digital health era. *Social Theory & Health*, *11*, pp.256-270.

Lupton, D., 2014. Critical perspectives on digital health technologies. *Sociology compass*, *8*(12), pp.1344-1359.

Ma, Q., Chan, A.H. and Chen, K., 2016. Personal and other factors affecting acceptance of smartphone technology by older Chinese adults. *Applied ergonomics*, *54*, pp.62-71.

Macedo, I.M., 2017. Predicting the acceptance and use of information and communication technology by older adults: An empirical examination of the revised UTAUT2. *Computers in Human Behavior*, *75*, pp.935-948.

Mackay, H. and Gillespie, G., 1992. Extending the social shaping of technology approach: ideology and appropriation. *Social studies of science*, *22*(4), pp.685-716.

MacKenzie, D. and Wajcman, J., 1999. *The social shaping of technology*. Open university press.

Maercker, A., Ben-Ezra, M., Esparza, O.A. and Augsburger, M., 2019. Fatalism as a traditional cultural belief potentially relevant to trauma sequelae: Measurement equivalence, extent and associations in six countries. *European Journal of Psychotraumatology*, *10*(1), p.1657371.

Majid, M.A.A., Othman, M., Mohamad, S.F., Lim, S.A.H. and Yusof, A., 2017. Piloting for interviews in qualitative research: Operationalization and lessons learnt. *International Journal of Academic Research in Business and Social Sciences*, *7*(4), pp.1073-1080.

Maller, C.J., 2015. Understanding health through social practices: performance and materiality in everyday life. *Sociology of health & illness*, *37*(1), pp.52-66.

Mannheim, I., van Zaalen, Y. and Wouters, E.J., 2022. Ageism in applying digital technology in healthcare: Implications for adoption and actual use. In *Digital transformations in care for older people*. Taylor & Francis.

Mantzoukas, S., Kotrotsiou, S., Mentis, M., Paschou, A., Diamantopoulos, E., Kotrotsiou, E. and Gouva, M., 2021. Exploring the impact of shame on health-

related quality of life in older individuals. *Journal of Nursing Scholarship*, *53*(4), pp.439-448.

Marres, N., 2019. As ANT is getting undone, can Pragmatism help us re-do it?. In A. Blok, I. Farías and C. Roberts, eds. 2020. *The Routledge Companion to Actor-Network Theory*, pp.112-120.

Martens, D. and Maalej, W., 2019. Towards understanding and detecting fake reviews in app stores. *Empirical Software Engineering*, *24*(6), pp.3316-3355.

Martin, A., Myers, N. and Viseu, A., 2015. The politics of care in technoscience. *Social studies of science*, *45*(5), pp.625-641.

Martín-García, A.V., Redolat, R. and Pinazo-Hernandis, S., 2022. Factors influencing intention to technological use in older adults. The TAM Model Aplication. *Research on Aging*, *44*(7-8), pp.573-588.

Martinato, M., Lorenzoni, G., Zanchi, T., Bergamin, A., Buratin, A., Azzolina, D. and Gregori, D., 2021. Usability and accuracy of a smartwatch for the assessment of physical activity in the elderly population: observational study. *JMIR mHealth and uHealth*, *9*(5), p.e20966.

Martins Van Jaarsveld, G., 2020. The effects of COVID-19 among the elderly population: a case for closing the digital divide. *Frontiers in psychiatry*, *11*, p.1211.

Matthes, J., 2022. Best Standalone Smartwatches (No Phone Needed). Available at: <https://sortatechy.com/best-standalone-smartwatches/> (Accessed Dec 6 2022)

Matthew-Maich, N., Harris, L., Ploeg, J., Markle-Reid, M., Valaitis, R., Ibrahim, S., Gafni, A. and Isaacs, S., 2016. Designing, implementing, and evaluating mobile health technologies for managing chronic conditions in older adults: a scoping review. *JMIR mHealth and uHealth*, *4*(2), p.e5127.

McCombs, M.E. and Shaw, D.L., 1972. The agenda-setting function of mass media. *Public opinion quarterly*, *36*(2), pp.176-187.

McCoy, S., Galletta, D.F. and King, W.R., 2007. Applying TAM across cultures: the need for caution. *European Journal of Information Systems*, *16*(1), pp.81-90.

Merkel, S. and Kucharski, A., 2019. Participatory design in gerontechnology: a systematic literature review. *The Gerontologist*, *59*(1), pp.e16-e25.

Milewa, T., 2006. Health technology adoption and the politics of governance in the UK. *Social Science & Medicine*, *63*(12), pp.3102-3112.

Miller, B., 2021. Is Technology Value-Neutral?. *Science, Technology, & Human Values*, 46(1), pp.53-80.

Miller, D., Rabho, L.A., Awondo, P., de Vries, M., Duque, M., Garvey, P., Haapio-Kirk, L., Hawkins, C., Otaegui, A., Walton, S. and Wang, X., 2021. *The Global Smartphone: Beyond a Youth Technology*. UCL Press.

Miller, J.D., 2004. Public understanding of, and attitudes toward, scientific research: What we know and what we need to know. *Public understanding of science*, *13*(3), pp.273-294.

Moore, P.V. and Woodcock, J., 2021. Augmented exploitation: artificial intelligence, automation, and work.

Moreira, T., 2016. *Science, technology and the ageing society*. Taylor & Francis.

Moretti, V. and Morsello, B., 2017. Self–management and type 1 diabetes. how technology redefines illness. *TECNOSCIENZA: Italian Journal of Science & Technology Studies*, *8*(1), pp.51-72.

Morris, J., Schlepper, L., Dayan, M., Jefferies, D., Maguire, D., Merry, L. and Wellings, D., 2023. Public satisfaction with the NHS and social care in 2022. *The Nuffield Trust*.

Mozur P., Zhong R. and Krolik A., 2020. In Coronavirus Fight, China Gives Citizens a Color Code, With Red Flags. Available at: <https://www.nytimes.com/2020/03/01/business/china-coronavirus-surveillance.html> (Accessed November 23 2022)

Mullan, E., 2018. The importance of app user ratings and reviews to your ASO strategy. Available at: <https://blog.hurree.co/blog/the-importance-of-app-user-ratings-and-reviews-to-your-aso-strategy>

Mwangi, M. and Kariuki, S., 2015. Factors determining adoption of new agricultural technology by smallholder farmers in developing countries. *Journal of Economics and sustainable development*, *6*(5).

National Health Commission, 2022. Circular on the issuance of the "14th Five-Year Plan" on Health Informatisation for the Whole Population. Available at: <http://www.nhc.gov.cn/cms-search/xxgk/getManuscriptXxgk.htm?id=49eb570ca79a42f688f9efac42e3c0f1>

National Science Board (US), 2000. *Science & engineering indicators*. National Science Board.

Nayak, L.U., Priest, L. and White, A.P., 2010. An application of the technology acceptance model to the level of Internet usage by older adults. *Universal Access in the Information Society*, *9*, pp.367-374.

Neff, G. and Fiore-Gartland, B., 2015. Communication, mediation, and the expectations of data: Data valences across health and wellness communities. *International Journal of Communication*, *9*, pp.1644-1484.

Neves, B.B. and Amaro, F., 2012. Too old for technology? How the elderly of Lisbon use and perceive ICT. *The journal of community informatics*, *8*(1), pp.1-12.

Neves, B.B. and Mead, G., 2021. Digital technology and older people: Towards a sociological approach to technology adoption in later life. *Sociology*, *55*(5), pp.888-905.

Neves, B.B., Franz, R.L., Munteanu, C., Baecker, R. and Ngo, M., 2015, April. "My Hand Doesn't Listen to Me!" Adoption and Evaluation of a Communication Technology for the 'Oldest Old'. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (pp. 1593-1602).

Neven, L., 2015. By any means? Questioning the link between gerontechnological innovation and older people's wish to live at home. *Technological forecasting and social change*, 93, pp.32-43.

Ngai, A., Bozza, A., Zhang, H., Chen, C. and Bennett, P., 2014. Transition between cultures? Beliefs and attitudes of British and Chinese young adults living in China and the UK towards mental health disorders. *International Journal of Culture and Mental Health*, *7*(1), pp.28-42.

NHS. 2021. Get your NHS COVID Pass letter. Available at: < https://www.nhs.uk/conditions/coronavirus-covid-19/covid-pass/get-your-covid-pass-letter/>

NHS England. 2017. Patient and public participation in commissioning health and care. Available at: <https://www.england.nhs.uk/wp-content/uploads/2017/05/patient-and-public-participation-guidance.pdf>

NHS England. 2022. A plan for digital health and social care. Available at: <https://www.gov.uk/government/publications/a-plan-for-digital-health-and-social-care/a-plan-for-digital-health-and-social-care>

Nikou, S., Agahari, W., Keijzer-Broers, W. and de Reuver, M., 2020. Digital healthcare technology adoption by elderly people: A capability approach model. *Telematics and Informatics*, *53*, p.101315.

O'Doherty, K.C., Christofides, E., Yen, J., Bentzen, H.B., Burke, W., Hallowell, N., Koenig, B.A. and Willison, D.J., 2016. If you build it, they will come: unintended future uses of organised health data collections. *BMC Medical Ethics*, *17*(1), pp.1-16.

Office for National Statistics. 2023. Profile of the older population living in England and Wales in 2021 and changes since 2011. Available at: <https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/ageing/articles/profileoftheolderpopulationlivinginenglandandwalesin2021andchangessince2011/2023-04-03>

Ogburn, W.F. and Thomas, D., 1922. Are inventions inevitable? A note on social evolution. *Political science quarterly*, *37*(1), pp.83-98.

Oke, A., Walumbwa, F., Yan, T., Idiagbon-Oke, M. and A. Ojode, L., 2014. Linking economic status with technology adoption in three emerging economies of Sub-Saharan Africa. *Journal of Manufacturing Technology Management*, *25*(1), pp.49-68

Olshansky, S.J., Beard, J. and Börsch-Supan, A., 2012. The longevity dividend: health as an investment. *Global Population Ageing: Peril or Promise?*, p.57.

Olson, K.E., O'Brien, M.A., Rogers, W.A. and Charness, N., 2011. Diffusion of technology: frequency of use for younger and older adults. *Ageing international*, 36(1), pp.123-145.

Olsson, T. and Viscovi, D., 2020. Who Actually Becomes a Silver Surfer? Prerequisites for Digital Inclusion. *Javnost-The Public*, *27*(3), pp.230-246.

Orth, U., Trzesniewski, K.H. and Robins, R.W., 2010. Self-esteem development from young adulthood to old age: a cohort-sequential longitudinal study. *Journal of personality and social psychology*, *98*(4), pp.645-658.

Oudshoorn, N., 2012. How places matter: Telecare technologies and the changing spatial dimensions of healthcare. *Social studies of science*, 42(1), pp.121-142.

Outila, M. and Kiuru, H., 2020. “Picturephone in My Home”: Actor-Network Theory and Foucauldian Discourse Analysis on Northern Finnish Older Adults Starting to Use a Video Conferencing Service. *Journal of Technology in Human Services*, *39*(2), pp.163-192.

Owen, R., Macnaghten, P. and Stilgoe, J., 2012. Responsible research and innovation: From science in society to science for society, with society. *Science and public policy*, *39*(6), pp.751-760.

Owen, R., Von Schomberg, R. and Macnaghten, P., 2021. An unfinished journey? Reflections on a decade of responsible research and innovation. *Journal of Responsible Innovation*, *8*(2), pp.217-233.

Oyebode, O., Alqahtani, F. and Orji, R., 2020. Using machine learning and thematic analysis methods to evaluate mental health apps based on user reviews. *IEEE Access*, *8*, pp.111141-111158.

Pacifico Silva, H., Lehoux, P., Miller, F.A. and Denis, J.L., 2018. Introducing responsible innovation in health: a policy-oriented framework. *Health research policy and systems*, *16*, pp.1-13.

Pagano, D. and Bruegge, B., 2013. User involvement in software evolution practice: A case study. In *2013 35th International Conference on Software Engineering (ICSE)* (pp. 953-962). IEEE.

Pagano, D. and Maalej, W., 2013. User feedback in the appstore: An empirical study. In *2013 21st IEEE international requirements engineering conference (RE)* (pp. 125-134). IEEE.

Pan, J., Dong, H. and Bryan-Kinns, N., 2021. Perception and Initial Adoption of Mobile Health Services of Older Adults in London: Mixed Methods Investigation. *JMIR aging*, *4*(4), p.e30420.

Pan, S. and Jordan-Marsh, M., 2010. Internet use intention and adoption among Chinese older adults: From the expanded technology acceptance model perspective. *Computers in human behavior*, *26*(5), pp.1111-1119.

Pan, Y., Chan, S.H., Xu, Y. and Yeung, K.C., 2019. Determinants of life satisfaction and self-perception of ageing among elderly people in China: An exploratory study in comparison between physical and social functioning. *Archives of Gerontology and Geriatrics*, *84*, p.103910.

Papoutsi, C., Wherton, J., Shaw, S., Morrison, C. and Greenhalgh, T., 2021. Putting the social back into sociotechnical: Case studies of co-design in digital health. *Journal of the American Medical Informatics Association*, *28*(2), pp.284-293.

Parasuraman, A., 2000. Technology Readiness Index (TRI) a multiple-item scale to measure readiness to embrace new technologies. *Journal of service research*, *2*(4), pp.307-320.

Parasuraman, A. and Colby, C.L., 2015. An updated and streamlined technology readiness index: TRI 2.0. *Journal of service research*, 18(1), pp.59-74.

Park, E., 2020. User acceptance of smart wearable devices: An expectation-confirmation model approach. *Telematics and Informatics*, *47*, p.101318.

Parkins, J.R., Rollins, C., Anders, S. and Comeau, L., 2018. Predicting intention to adopt solar technology in Canada: The role of knowledge, public engagement, and visibility. *Energy Policy*, *114*, pp.114-122.

Parthasarathy, S., 2015. Co-producing knowledge and political legitimacy: Comparing life form patent controversies in Europe and the United States. In *Science and Democracy* (pp. 74-93). Routledge.

Peacock, S.E. and Künemund, H., 2007. Senior citizens and Internet technology: Reasons and correlates of access versus non-access in a European comparative perspective. *European journal of ageing*, *4*, pp.191-200.

Peek, S.T., Luijkx, K.G., Rijnaard, M.D., Nieboer, M.E., Van Der Voort, C.S., Aarts, S., Van Hoof, J., Vrijhoef, H.J. and Wouters, E.J., 2016. Older adults' reasons for using technology while aging in place. *Gerontology*, *62*(2), pp.226-237

Peek, S.T.M., Wouters, E.J., Luijkx, K.G. and Vrijhoef, H.J., 2016. What it takes to successfully implement technology for aging in place: focus groups with stakeholders. *Journal of medical Internet research*, *18*(5), p.e5253.

Peine, A., 2019. Technology and ageing—Theoretical propositions from science and technology studies (STS). In *Ageing and digital technology* (pp. 51-64). Springer, Singapore.

Peine, A., Faulkner, A., Jæger, B. and Moors, E., 2015. Science, technology and the 'grand challenge' of ageing—Understanding the socio-material constitution of later life. *Technological Forecasting and Social Change*, *93*, pp.1-9.

Perez, C.C., 2019. *Invisible women: Exposing data bias in a world designed for men*. Random House.

Pernot-Leplay, E., 2020. China's approach on data privacy law: a third way between the US and the EU?. *Penn St. JL & Int'l Aff.*, *8*, p.49.

Perry, S. 2020. Older people are more likely to be emotionally stable, study suggests. Available at: <https://www.minnpost.com/second-opinion/2020/04/older-people-are-more-likely-to-be-emotionally-stable-study-suggests/>

Peterson, K.F. and Adams-Price, C., 2022. Fear of dependency and life-space mobility as predictors of attitudes toward assistive devices in older adults. *The International Journal of Aging and Human Development*, *94*(3), pp.273-289.

Phang, C.W., Li, Y., Sutanto, J. and Kankanhalli, A., 2005, January. Senior citizens' adoption of e-government: In quest of the antecedents of perceived usefulness. In *Proceedings of the 38th annual Hawaii international conference on system sciences* (pp. 130a-130a). IEEE.

Phoenix, C., 2018. Why qualitative research is needed in gerontology and how we can do it better. *The Journals of Gerontology: Series B*, *73*(7), pp.e81-e85.

Pickersgill, M., 2012. The co-production of science, ethics, and emotion. *Science, Technology, & Human Values*, *37*(6), pp.579-603.

Pieczka, M. and Escobar, O., 2013. Dialogue and science: Innovation in policy-making and the discourse of public engagement in the UK. *Science and Public Policy*, *40*(1), pp.113-126.

Pion, G.M. and Lipsey, M.W., 1981. Public attitudes toward science and technology: What have the surveys told us?. *Public Opinion Quarterly*, 45(3), pp.303-316.

Pirhonen, J., Lolich, L., Tuominen, K., Jolanki, O. and Timonen, V., 2020. "These devices have not been made for older people's needs"–Older adults'

perceptions of digital technologies in Finland and Ireland. *Technology in Society*, p.101287.

Pottinger, L., 2021. Gentle Methodologies. In: A. Barron, A.L. Browne, U. Ehgartner, S.M. Hall, L. Pottinger and J. Ritson, eds. 2021. *Methods for Change: Impactful social science methodologies for 21st century problems*. Manchester: Aspect and The University of Manchester, pp.32-40.

PytlikZillig, L.M. and Tomkins, A.J., 2011. Public engagement for informing science and technology policy: What do we know, what do we need to know, and how will we get there?. *Review of policy research*, 28(2), pp.197-217.

Rasche, P., Wille, M., Bröhl, C., Theis, S., Schäfer, K., Knobe, M. and Mertens, A., 2018. Prevalence of health app use among older adults in Germany: national survey. *JMIR mHealth and uHealth*, *6*(1), p.e8619.

Rawlinson, K. and Geddes, L, 2021. NHS app will be used as Covid 'vaccine passport' for foreign travel. Available at: <https://www.theguardian.com/world/2021/apr/28/covid-nhs-app-will-be-used-as-vaccine-passport-for-foreign-travel>

Rekanar, K., Buckley, J., Buckley, S., Abbas, M., Beechum, S., Chochlov, M., Fitzgerald, B., Glynn, L., Johnson, K., Laffey, J. and McNicholas, B., 2020. Sentiment Analysis of User Feedback on the HSE Contact Tracing App. [Preprint from Research Square].

Restrepo, H.E. and Rozental, M., 1994. The social impact of aging populations: some major issues. *Social science & medicine*, *39*(9), pp.1323-1338.

Rich, E. and Miah, A., 2017. Mobile, wearable and ingestible health technologies: towards a critical research agenda. *Health Sociology Review*, *26*(1), pp.84-97.

Riddell, W.C. and Song, X., 2017. The role of education in technology use and adoption: Evidence from the Canadian workplace and employee survey. *ILR Review*, 70(5), pp.1219-1253.

Rivard, L. and Lehoux, P., 2020. When desirability and feasibility go hand in hand: innovators' perspectives on what is and is not responsible innovation in health. *Journal of Responsible Innovation*, *7*(1), pp.76-95.

Robertson, L. and Hale, B., 2011. Interviewing older people; relationships in qualitative research. *Internet Journal of Allied Health Sciences and Practice*, *9*(3), p.10.

Robinson, E.J. and Henderson, C., 2019. Public knowledge, attitudes, social distance and reporting contact with people with mental illness 2009–2017. *Psychological Medicine*, *49*(16), pp.2717-2726.

Rogers, E.M., 1995. *Diffusion of innovations, 4th Edition*. New York: Free Press.

Rose, D. and Blume, S., 2003. Citizens as users of technology: An exploratory study of vaccines and vaccination. In N. Oudshoorn and T. Pinch, eds., *Now users matter: The co-construction of users and technology* (pp.103-131). The MIT Press. Ch.5.

Rowe, J.W. and Kahn, R.L., 1987. Human aging: usual and successful. *Science*, *237*(4811), pp.143-149.

Rowe, J.W. and Kahn, R.L., 1997. Successful aging. *The gerontologist*, *37*(4), pp.433-440.

Rudnicka, E., Napierała, P., Podfigurna, A., Męczekalski, B., Smolarczyk, R. and Grymowicz, M., 2020. The World Health Organization (WHO) approach to healthy ageing. *Maturitas*, *139*, pp.6-11.

Russell, S. and Williams, R., 2002. Social shaping of technology: frameworks, findings and implications for policy with glossary of social shaping concepts. *Shaping technology, guiding policy: Concepts, spaces and tools*, pp.37-132.

Safarov, N., 2021. Personal experiences of digital public services access and use: Older migrants' digital choices. *Technology in Society*, *66*, p.101627.

Sagner, A., Kowal, P. and Dowd, J.E., 2002. *Defining "Old Age". Markers of old age in sub-Saharan Africa and the implications for cross-cultural research*. Technical Report, WHO.

Sample, M., Sattler, S., Blain-Moraes, S., Rodríguez-Arias, D. and Racine, E., 2020. Do publics share experts' concerns about brain–computer interfaces? A trinational survey on the ethics of neural technology. *Science, Technology, & Human Values*, *45*(6), pp.1242-1270.

Sanders, R., 2017. Self-tracking in the digital era: Biopower, patriarchy, and the new biometric body projects. *Body & Society*, *23*(1), pp.36-63.

Sasse, T. and Hodgkin, R., 2021. Covid passports: key questions for the government. *IFG Insight*.

Sauchelli, S., Pickles, T., Voinescu, A., Choi, H., Sherlock, B., Zhang, J., Colyer, S., Grant, S., Sundari, S. and Lasseter, G., 2023. Public attitudes towards the use of novel technologies in their future healthcare: a UK survey. *BMC Medical Informatics and Decision Making*, *23*(1), p.38.

Scott, A., 2018. *The myth of an "ageing society"*. Available at: <https://www.weforum.org/agenda/2018/05/the-myth-of-the-aging-society>

Seedsman, T., 2019. Aging, informed consent and autonomy: ethical issues and challenges surrounding research and long-term care. *OBM Geriatrics*, *3*(2), pp.1-30.

Seifert, A. and Schelling, H.R., 2015. Mobile use of the Internet using smartphones or tablets by Swiss people over 65 years. *Gerontechnology*, *14*(1), pp.57-62.

Selwyn, N., 2004. The information aged: A qualitative study of older adults' use of information and communications technology. *Journal of Aging studies*, *18*(4), pp.369-384.

Selwyn, N., 2009, July. The digital native–myth and reality. In *Aslib proceedings* (Vol. 61, No. 4, pp. 364-379). Emerald Group Publishing Limited.

Shannon, C.E., 1948. A mathematical theory of communication. *The Bell system technical journal*, *27*(3), pp.379-423.

Sharma, A., Harrington, R.A., McClellan, M.B., Turakhia, M.P., Eapen, Z.J., Steinhubl, S., Mault, J.R., Majmudar, M.D., Roessig, L., Chandross, K.J. and Green, E.M., 2018. Using digital health technology to better generate evidence and deliver evidence-based care. *Journal of the American College of Cardiology*, *71*(23), pp.2680-2690.

Shashaani, L., 1994. Gender-differences in computer experience and its influence on computer attitudes. *Journal of Educational Computing Research*, *11*(4), pp.347-367.

Sherwin, S. and Winsby, M., 2011. A relational perspective on autonomy for older adults residing in nursing homes. *Health Expectations*, *14*(2), pp.182-190.

Sin, C., 2007. Older people from white-British and Asian-Indian backgrounds and their expectations for support from their children. *Quality in Ageing and Older Adults*.

Sismondo, S., 2010. *An introduction to science and technology studies* (Vol. 1). Chichester: Wiley-Blackwell.

Siu, J.Y.M., 2021. Perceptions of seasonal influenza and pneumococcal vaccines among older Chinese adults. *The Gerontologist*, *61*(3), pp.439-448.

Sixsmith, A. and Sixsmith, J., 2008. Ageing in place in the United Kingdom. *Ageing International*, *32*(3), pp.219-235.

Slavov, M. 2021. Why are phones so heavy? Available at: < https://www.phonearena.com/news/Why-are-phones-so-heavy_id125400>

Smallman, M., 2018. Science to the rescue or contingent progress? Comparing 10 years of public, expert and policy discourses on new and emerging science and technology in the United Kingdom. *Public Understanding of Science*, 27(6), pp.655-673.

Smallman, M., 2022. Multi scale ethics—why we need to consider the ethics of AI in Healthcare at different scales. *Science and Engineering Ethics*, *28*(6), p.63.

Smallman, M, Lock, S. and Miller, S., 2020. United Kingdom: The developing relationship between science and society. In: Gascoigne, T., Schiele, B., Leach, J., Riedlinger, M., Lewenstein, B., Massarani, L. and Broks P., ed. 2020. *Communicating science: a global perspective*. ANU (Australian National University) Press. Ch. 39.

Sointu, E., 2006. The search for wellbeing in alternative and complementary health practices. *Sociology of health & illness*, *28*(3), pp.330-349.

Spatar, D., Kok, O., Basoglu, N. and Daim, T., 2019. Adoption factors of electronic health record systems. *Technology in Society*, 58, p.101144.

Sponselee, A.M., Schouten, B., Bouwhuis, D. and Willems, C., 2007, November. Smart home technology for the elderly: Perceptions of multidisciplinary

stakeholders. In *European Conference on Ambient Intelligence* (pp. 314-326). Springer, Berlin, Heidelberg.

Stahl, B.C. and Coeckelbergh, M., 2016. Ethics of healthcare robotics: Towards responsible research and innovation. *Robotics and Autonomous Systems*, *86*, pp.152-161.

Stahl, B.C., McBride, N., Wakunuma, K. and Flick, C., 2014. The empathic care robot: A prototype of responsible research and innovation. *Technological Forecasting and Social Change*, *84*, pp.74-85.

Staley, K. and Doherty, C., 2016. It's not evidence, it's insight: bringing patients' perspectives into health technology appraisal at NICE. *Research Involvement and Engagement*, *2*(1), pp.1-12.

Stephens, C., Breheny, M. and Mansvelt, J., 2015. Healthy ageing from the perspective of older people: A capability approach to resilience. *Psychology & health*, *30*(6), pp.715-731.

Stilgoe, J., Lock, S.J. and Wilsdon, J., 2014. Why should we promote public engagement with science?. *Public understanding of science*, *23*(1), pp.4-15.

Sturgis, P. and Allum, N., 2004. Science in society: re-evaluating the deficit model of public attitudes. *Public understanding of science*, *13*(1), pp.55-74.

Su, J. and Tong, X., 2021. Catching silver consumers in China: an integrated model of Chinese older adults' use of social networking technology. *Asia Pacific Journal of Marketing and Logistics*, *33*(9), pp.1903-1917.

Su, Q.Y. and Li, X.W., 2010, August. Age/gender/occupation and mobile phone technology adoption: A cross-cultural study in China (Beijing) and the UK (Portsmouth). In *2010 International Conference on Management and Service Science* (pp. 1-4). IEEE.

Sukriti, K.C., Tewolde, S., Laverty, A.A., Costelloe, C., Papoutsi, C., Reidy, C., Gudgin, B., Shenton, C., Majeed, A., Powell, J. and Greaves, F., 2023. Uptake and adoption of the NHS App in England: an observational study. *British Journal of General Practice*, *73*(737), pp.e932-e940.

Sun, Y. and Wang, W.Y., 2022. Governing with health code: Standardising China's data network systems during COVID-19. *Policy & Internet*.

Sung, K.T., 2004. Elder respect among young adults: A cross-cultural study of Americans and Koreans. *Journal of Aging Studies*, *18*(2), pp.215-230.

Susanto, T.D. and Goodwin, R., 2013. User acceptance of SMS-based e-government services: Differences between adopters and non-adopters. *Government Information Quarterly*, *30*(4), pp.486-497.

Tabassum, N., 2020. How are older people adapting to digital technology during the COVID-19 pandemic. Available at: <https://www.ageing-better.org.uk/blogs/how-are-older-people-adapting-digital-technology-during-covid-19-pandemic>

Talukder, M., 2012. Factors affecting the adoption of technological innovation by individual employees: An Australian study. *Procedia-Social and Behavioral Sciences*, 40, pp.52-57.

Tan, S., 2020. China's Novel Health Tracker: Green on Public Health, Red on Data Surveillance. Available at: <https://www.csis.org/blogs/trustee-china-hand/chinas-novel-health-tracker-green-public-health-red-data-surveillance> (Accessed November 27 2022)

Teo, T., Luan, W.S. and Sing, C.C., 2008. A cross-cultural examination of the intention to use technology between Singaporean and Malaysian pre-service teachers: an application of the Technology Acceptance Model (TAM). *Journal of Educational Technology & Society*, *11*(4), pp.265-280.

The Royal Society, 2017. Data governance: public engagement review. Available at: <https://royalsociety.org/-/media/policy/projects/data-governance/data-governance-public-engagement-review.pdf>

The State Council of China, 2017. Opinions on the formulation and implementation of elderly care service programmes. Available at: <https://www.gov.cn/zhengce/content/2017-06/16/content_5203088.htm>

The State Council of China, 2022. A guideline to promote the development of national undertakings for the aged and improve the elderly care service system during the 14th Five-Year Plan period (2021-2025). Available at: <https://www.gov.cn/zhengce/content/2022-02/21/content_5674844.htm>

The World Bank, 2023. Life expectancy at birth, total (years). Available at: < https://data.worldbank.org/indicator/SP.DYN.LE00.IN>

Thimbleby, H., 2013. Technology and the future of healthcare. *Journal of public health research*, *2*(3), pp.160-167.

Thomas, M., 2011. Technology, education, and the disclosure of the digital native. In: Thomas, M. ed., 2011. *Deconstructing digital natives: Young people, technology, and the new literacies*. Taylor & Francis.

Thornton, N., Horton, T., Hardie, T. and Coxon, C., 2023. Exploring public attitudes towards the use of digital health technologies and data. Available at: <https://www.health.org.uk/publications/long-reads/exploring-public-attitudes-towards-the-use-of-digital-health-technologies>

Tlili, A. and Dawson, E., 2010. Mediating science and society in the EU and UK: From information-transmission to deliberative democracy?. *Minerva*, *48*, pp.429-461.

Tu, J., Shen, M., Zhong, J., Yuan, G. and Chen, M., 2021. The perceptions and experiences of mobile health technology by older people in Guangzhou, China: a qualitative study. *Frontiers in public health*, *9*, p.840.

Tural, E., Lu, D. and Cole, D.A., 2020. Factors predicting older Adults' attitudes toward and intentions to use stair mobility assistive designs at home. *Preventive Medicine Reports*, *18*, p.101082.

Turkle, S., 2005. *The second self: Computers and the human spirit*. Mit Press.

UK Health Security Agency, 2021. NHS Covid Pass. Available at: < https://www.gov.uk/guidance/nhs-covid-pass#full-publication-update-history>

UNESCO, 2019. New report on global broadband access underscores urgent need to reach the half of the world still unconnected. Available at: <https://en.unesco.org/news/new-report-global-broadband-access-underscores-urgent-need-reach-half-world-still-unconnected>

United Nations, 2017. *World Population Ageing 2017 Highlights*. Available at: <https://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2017_Highlights.pdf>

United Nations, 2018. Health inequalities in old age. Available at: <https://www.un.org/development/desa/ageing/news/2018/04/health-inequalities-in-old-age/>

United Nations. 2020. Decade of healthy ageing: 2021-2030. Available at: <https://social.desa.un.org/sdn/decade-of-healthy-ageing-2021-2030>

University of Sheffield., 2015. Specialist research ethics guidance paper: Ethical considerations in research involving older people. Sheffield, UK: University of Sheffield. Available at: <https://studylib.net/doc/18570632/ethical-considerations-in-research-involving-older-people>

Van de Vijver, F. and Tanzer, N.K., 2004. Bias and equivalence in cross-cultural assessment: An overview. *European review of applied psychology*, *54*(2), pp.119-135.

Van Dijk, J., 2005. The Deepening Divide, Inequality in the Information Society. Sage Publications.

Van Dijk, J.A., 2006. Digital divide research, achievements and shortcomings. *Poetics*, 34(4-5), pp.221-235.

Van Teijlingen, E. and Hundley, V., 2001. The importance of pilot studies. *Social research update*, (35), pp.1-4.

Vaportzis, E., Giatsi Clausen, M. and Gow, A.J., 2017. Older adults perceptions of technology and barriers to interacting with tablet computers: a focus group study. *Frontiers in psychology*, *8*, p.1687.

Vasa, R., Hoon, L., Mouzakis, K. and Noguchi, A., 2012. A preliminary analysis of mobile app user reviews. In *Proceedings of the 24th Australian computer-human interaction conference* (pp. 241-244).

Vaziri, D.D., Unbehaun, D., Aal, K., Shklovski, I., Wieching, R., Schreiber, D. and Wulf, V., 2019. Negotiating contradictions: engaging disparate stakeholder demands in designing for active and healthy ageing. *Journal of Enabling Technologies*, *13*(1), pp.40-50.

Venkatesh, V. and Bala, H., 2008. Technology acceptance model 3 and a research agenda on interventions. *Decision sciences*, *39*(2), pp.273-315.

Venkatesh, V. and Davis, F.D., 2000. A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management science*, *46*(2), pp.186-204.

Venkatesh, V., Morris, M.G., Davis, G.B. and Davis, F.D., 2003. User acceptance of information technology: Toward a unified view. *MIS quarterly*, pp.425-478.

Venkatesh, V., Thong, J.Y. and Xu, X., 2012. Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS quarterly*, pp.157-178.

Verbeek, P.P., 2006. Materializing morality: Design ethics and technological mediation. *Science, Technology, & Human Values*, 31(3), pp.361-380.

Verdegem, P. and Verhoest, P., 2009. Profiling the non-user: Rethinking policy initiatives stimulating ICT acceptance. *Telecommunications Policy*, *33*(10-11), pp.642-652.

Vicente, P. and Lopes, I., 2016. Attitudes of older mobile phone users towards mobile phones. *Communications*, *41*(1), pp.71-86.

Victor, C.R. and Bowling, A., 2012. A longitudinal analysis of loneliness among older people in Great Britain. *The Journal of psychology*, 146(3), pp.313-331.

Victor, C.R. and Yang, K., 2012. The prevalence of loneliness among adults: a case study of the United Kingdom. *The Journal of psychology*, *146*(1-2), pp.85-104.

Vishwanath, A. and Goldhaber, G.M., 2003. An examination of the factors contributing to adoption decisions among late-diffused technology products. *New media & society*, *5*(4), pp.547-572.

Viswanath, K. and Kreuter, M.W., 2007. Health disparities, communication inequalities, and eHealth. *American journal of preventive medicine*, *32*(5), pp.S131-S133.

Vulpe, S. and Ilinca, C., 2020. Age and usage of technology. a structural equation model based on the theory of planned behavior. *Revista Universitară de Sociologie*. Year XVI, no. 2.

Wagner, J., Ram, N., Smith, J. and Gerstorf, D., 2016. Personality trait development at the end of life: Antecedents and correlates of mean-level trajectories. *Journal of Personality and Social Psychology*, *111*(3), p.411.

Walker, A., 2002. A strategy for active ageing. *International social security review*, 55(1), pp.121-139.

Wallace, S.E., Graham, C. and Saraceno, A., 2013. Older adults' use of technology. *Perspectives on Gerontology*, *18*(2), pp.50-59.

Walshe, J., Elphinstone, B., Nicol, D. and Taylor, M., 2024. A systematic literature review of the 'commercialisation effect' on public attitudes towards biobank and genomic data repositories. *Public Understanding of Science*, p.09636625241230864.

Wang, C. and Qi, H., 2021. Influencing factors of acceptance and use behavior of mobile health application users: systematic review. In *Healthcare* (Vol. 9, No. 3, p. 357). MDPI.

Wang, D., Zhong, Q. and Jia H., 2015. Science communication: From popularization of science to public participation in science. *Shanghai Journalism Review*, 6.

Wang, H., 2010. An analysis of public participation in technology design in the perspective of Instrumentalisation Theory. *Science & Technology Progress and Policy*, *27*(05), pp.14-16.

Wang, X., 2023. *Ageing with Smartphones in Urban China: From the cultural to the digital revolution in Shanghai*. UCL Press.

Wang, Z. and Yu, Q., 2015. Privacy trust crisis of personal data in China in the era of Big Data: The survey and countermeasures. *Computer Law & Security Review*, *31*(6), pp.782-792.

Wang, Z.D., Wang, Y.M., Li, K., Shi, J. and Wang, F.Y., 2021. The comparison of the wisdom view in Chinese and Western cultures. *Current Psychology*, pp.1-12.

Ware, P., Bartlett, S.J., Paré, G., Symeonidis, I., Tannenbaum, C., Bartlett, G., Poissant, L. and Ahmed, S., 2017. Using eHealth technologies: interests, preferences, and concerns of older adults. *Interactive journal of medical research*, *6*(1), p.e4447.

Warmoth, K., Tarrant, M., Abraham, C. and Lang, I.A., 2018. Relationship between perceptions of ageing and frailty in English older adults. *Psychology, health & medicine*, *23*(4), pp.465-474.

Weingart, P., Joubert, M. and Connoway, K., 2021. Public engagement with science—Origins, motives and impact in academic literature and science policy. *PloS one*, *16*(7), p.e0254201.

Wen, D., Zhang, X. and Lei, J., 2017. Consumers' perceived attitudes to wearable devices in health monitoring in China: A survey study. *Computer methods and programs in biomedicine*, *140*, pp.131-137.

Wenger, G.C., 2002. Interviewing older people. *Handbook of interview research: Context and method*, pp.259-278.

Westerhof, G.J., Barrett, A.E. and Steverink, N., 2003. Forever young? A comparison of age identities in the United States and Germany. *Research on Aging*, *25*(4), pp.366-383.

White, A., 2009. From comfort zone to performance management: Understanding Development and Performance. White & MacLean Publishing.

Wilkinson, C., Bultitude, K. and Dawson, E., 2011. “Oh yes, robots! People like robots; the robot people should do something”: perspectives and prospects in public engagement with robotics. *Science Communication*, *33*(3), pp.367-397.

Wilkowska, W., Brauner, P. and Ziefle, M., 2018. Rethinking technology development for older adults: A responsible research and innovation duty. In *Aging, Technology and Health* (pp. 1-30). Academic Press.

Williams, R. and Edge, D., 1996. The social shaping of technology. *Research policy*, *25*(6), pp.865-899.

Williams, S.N., Armitage, C.J., Tampe, T. and Dienes, K., 2021. Public attitudes towards COVID-19 contact tracing apps: A UK-based focus group study. *Health Expectations*, *24*(2), pp.377-385.

Wilsdon, J. and Willis, R., 2004. *See-through science: Why public engagement needs to move upstream*. Demos.

Wilska, T.A. and Pedrozo, S., 2007. New technology and young people’s consumer identitites: A comparative study between Finland and Brazil. *Young*, *15*(4), pp.343-368.

Wilson, J., Heinsch, M., Betts, D., Booth, D. and Kay-Lambkin, F., 2021. Barriers and facilitators to the use of e-health by older adults: a scoping review. *BMC public health*, *21*, pp.1-12.

Winner, L., 1980. Do artifacts have politics?. *Daedalus*, *109*(1), pp.121-36.

Woodcock, A., McDonagh, D., Magee, P. and Tovey, M., 2020. The Value and Place for Empathy in Designing for Older People. *Design of Assistive Technology for Ageing Populations*, pp.59-77.

Woolgar, S., 1990. Configuring the user: the case of usability trials. *The Sociological Review*, *38*(1_suppl), pp.58-99.

World Health Organisation, 2002. Active ageing: a policy framework. Available at: <https://iris.who.int/handle/10665/67215>

World Health Organization, 2015. World report on ageing and health. Available at: <https://apps.who.int/iris/handle/10665/186463>

World Health Organization. 2021. Global strategy on digital health 2020-2025. Available at: <https://www.who.int/docs/default-source/documents/gs4dhdaa2a9f352b0445bafbc79ca799dce4d.pdf>

Wu, J., Wang, J., Nicholas, S., Maitland, E. and Fan, Q., 2020. Application of big data technology for COVID-19 prevention and control in China: lessons and recommendations. *Journal of medical Internet research*, *22*(10), p.e21980.

Wyatt, S.M., 2003. Non-users also matter: The construction of users and non-users of the Internet. In N. Oudshoorn and T. Pinch, eds., *Now users matter: The co-construction of users and technology* (pp.67-79). The MIT Press. Ch.3.

Wynne, B., 1992. Misunderstood misunderstanding: social identities and public uptake of science. *Public understanding of science*, 1, pp.281-304.

Wynne, B., 2007. Public participation in science and technology: performing and obscuring a political–conceptual category mistake. East Asian Science, Technology and Society: An International Journal, 1(1), pp.99-110.

Xinhua, 2021. China working on plan to raise retirement age. Available at: <https://english.www.gov.cn/statecouncil/ministries/202102/26/content_WS6038de70c6d0719374af99f2.html> (Accessed November 21 2023)

Xiong, Y., 1998. Intergenerational relationship and elderly care in Chinese urban families. *Chinese Journal of Population Science*, 6, pp.15-21.

Yang, S., 2022. Differences in the concept of privacy in cross-cultural communication. *Nanfang Magazine*, *6*, pp.78-80.

Ye, P., Jin, Y., Er, Y., Duan, L., Palagyi, A., Fang, L., Li, B., Ivers, R., Keay, L. and Tian, M., 2021. A scoping review of national policies for healthy ageing in mainland China from 2016 to 2020. *The Lancet Regional Health–Western Pacific*, *12*.

Yerrakalva, D., Yerrakalva, D., Hajna, S. and Griffin, S., 2019. Effects of mobile health app interventions on sedentary time, physical activity, and fitness in older adults: systematic review and meta-analysis. *Journal of medical Internet research*, *21*(11), p.e14343.

Yi, B., 2021. An overview of the Chinese healthcare system. *Hepatobiliary Surgery and Nutrition*, *10*(1), p.93.

Yi, F., Men, D., Cheng, S. and Liu, C., 2023, July. Function and Visual Experience Design Strategy of Chinese Elderly Health Monitoring Smartwatch. In *International Conference on Human-Computer Interaction* (pp. 516-527). Cham: Springer Nature Switzerland.

Yin, R., Xin, Y., Bhura, M., Wang, Z. and Tang, K., 2022. Bridge Employment and Longevity: Evidence From a 10-Year Follow-Up Cohort Study in 0.16 Million Chinese. *The Journals of Gerontology: Series B*, *77*(4), pp.750-758.

Young, R., Willis, E., Cameron, G. and Geana, M., 2014. “Willing but unwilling”: attitudinal barriers to adoption of home-based health information technology among older adults. *Health informatics journal*, *20*(2), pp.127-135.

Yu, H., 2024. Living in the era of codes: a reflection on China’s health code system. *BioSocieties*, *19*(1), pp.1-18.

Yusif, S., Soar, J. and Hafeez-Baig, A., 2016. Older people, assistive technologies, and the barriers to adoption: A systematic review. *International journal of medical informatics*, *94*, pp.112-116.

Zhang, L., 2021. A latent class analysis of health lifestyles and health outcomes among Chinese older adults. *Ageing & Society*, *41*(2), pp.313-338.

Zhang, M., 2023. Older people's attitudes towards emerging technologies: A systematic literature review. *Public Understanding of Science*, *32*(8), pp.948-968.

Zhang, T., 2017. Social adaptation of retired elderly from the Retirement Syndrome in contemporary China. *Laodong Baozhang Shijie*, 23, pp. 9+11.

Zhang, W., Zhou, Y., Li, J., Zeng, T. and Liao, J., 2021. Does the attention of the Chinese government influence Chinese nutrition, exercise, and health? Based on the content analysis of the central government work reports from 1978 to 2020. *Frontiers in Nutrition*, *8*, p.724176.

Zhang, X., 2013. Income disparity and digital divide: The Internet Consumption Model and cross-country empirical research. *Telecommunications Policy*, *37*(6-7), pp.515-529.

Zhang, X., Lewis, S., Firth, J., Chen, X. and Bucci, S., 2021. Digital mental health in China: a systematic review. *Psychological medicine*, *51*(15), pp.2552-2570.

Zhang, Y., 2016. Practising and displaying xiao—young mothers' negotiations of obligations to elders. *The Journal of Chinese Sociology*, *3*(1), p.27.

Zhao, D. and Hu, W., 2017. Determinants of public trust in government: Empirical evidence from urban China. *International Review of Administrative Sciences*, *83*(2), pp.358-377.

Zhao, Y. and Liao, M., 2019. Chinese perspectives on responsible innovation. In *International Handbook on Responsible Innovation* (pp. 426-440). Edward Elgar Publishing.

Zhao, Y., Fautz, C., Hennen, L., Srinivas, K.R. and Li, Q., 2015. Public engagement in the governance of science and technology. *Science and technology governance and ethics: A global perspective from Europe, India and China*, pp.39-51.

Zhu, H., Xiong, H., Ge, Y. and Chen, E., 2014. Discovery of ranking fraud for mobile apps.*IEEE Transactions on knowledge and data engineering*, *27*(1), pp.74-87.

Zou, X., Fitzgerald, R. and Nie, J.B., 2020. “Unworthy of Care and Treatment”: Cultural Devaluation and Structural Constraints to Healthcare-Seeking for Older People in Rural China. *International Journal of Environmental Research and Public Health*, *17*(6), p.2132.

Zuo, H.J., Ma, J.X., Wang, J.W. and Chen, X.R., 2020. Assessing the routine-practice gap for home blood pressure monitoring among Chinese adults with hypertension. *BMC Public Health*, *20*, pp.1-9.

Appendix 1: Sample recruitment information

Hello! My name is Mengxi Zhang and I am a doctoral student at University College London in the field of Science and Technology Studies. I am currently doing research on older people's life and technology and hope to seek help from you. (My name and research project could be found on the website of UCL STS: https://www.ucl.ac.uk/sts/people/current-doctoral-students.)

My research project aims to understand older people's life experiences and find out their attitudes towards people and artifacts they interact with in their lives and health-related behaviours (such as taking exercises, diet, receiving care services). I hope to recruit 30 older people in the UK to have a talk with me. Each interview will last about 1 hour, and we can discuss about a convenient place for interview in advance.

If you are an older people interested in taking part, or you know someone may be interested in participating, please email me at (contact details removed) for further information. I will be grateful if you could also forward this recruitment information to other people who might be interested.

Please do not hesitate to contact me if you had any questions or suggestions. I really need your help and thank you for any support!

Mengxi Zhang
Department of Science and Technology Studies
University College London

Appendix 2: Participant information sheet

Name and Contact Details of the Researcher:
Mengxi Zhang (contact details removed)
Name and Contact Details of the Supervisor:
Melanie Smallman (contact details removed)

1. Invitation
I would like to invite you to participate in my PhD research project. Before you decide whether to take part, it is important for you to understand why the research is being done and what participation will involve. Please take time to read the following information carefully. Ask me if there is anything that is not clear or if you would like more information. Thank you for reading this.

2. What is the project's purpose?
The project aims to understand older people's life experiences and find out their attitudes towards people and artifacts they interact with in their lives and health-related behaviours. (For caregivers and technology workers, you are invited to give your opinions on this topic, and I hope to know how you are involved.)

3. Do I have to take part?
Participation is completely voluntary, and it is up to you to decide whether or not to take part. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. You can withdraw at any time without giving a reason and withdrawing from the study will not affect you in any way. If you decide to withdraw you will be asked what you wish to happen to the data you have provided up to that point.

4. What will happen to me if I take part?
If you choose to take part in the study, you will be asked to participate in an interview or focus group. The interview or focus group will take place via face-to-face talks or video calls, and it will take about 1-1.5 hours.

5. Will I be recorded and how will the recorded media be used?
I will record the interview/focus group with your permission. The audio recordings will be only for academic use. You have the right to request a copy of the recordings and transcriptions of the interview and amend any inaccurate data about yourself. No other use will be made of them without your permission, and no one outside the project will be allowed access to the recordings. The original recordings will be destroyed once the transcription is fully completed.

6. What are the possible disadvantages and risks of taking part?

You can rest assure that your name and any private information (such as your health condition) will not be disclosed in this study. If you have any discomforts during or after the interviews, please contact me and I will delete the information that you do not want to disclose in the research project.

7. What if something goes wrong?

If this study has harmed you in any way or if you wish to make a complaint about the conduct of the study you can contact University College London using the details below for further advice and information:

Researcher: Mengxi Zhang (contact details removed)

Supervisor: Melanie Smallman (contact details removed)

If you find something serious occurring during or following the participation in the project, or your complaint are not handled to your satisfaction, you can contact the Chair of the UCL Research Ethics Committee (ethics@ucl.ac.uk).

8. Will my taking part in this project be kept confidential?

All the information collected about you will be kept strictly confidential. You will not be able to be identified in any ensuing reports or publications.

9. Limits to confidentiality

- Please note that assurances on confidentiality will be strictly adhered to unless evidence of wrongdoing or potential harm is uncovered. In such cases, the University may be obliged to contact relevant statutory bodies/agencies.
- Please note that confidentiality will be maintained as far as it is possible unless during our conversation I hear anything which makes me worried that someone might be in danger of harm, I might have to inform relevant agencies of this.
- Confidentiality will be respected subject to legal constraints and professional guidelines.
- Confidentiality will be respected unless there are compelling and legitimate reasons for this to be breached. If this was the case, I would inform you of any decisions that might limit your confidentiality.
- Confidentiality may be limited and conditional and the researcher has a duty of care to report to the relevant authorities possible harm/danger to the participant or others.

10. What will happen to the results of the research project?

I will present the results in my PhD thesis. Once the thesis is completed or published in any form, please feel free to ask for a copy. The data collected

during the project might be used for additional or subsequent research, but you will not be identified in any report or publication.

11. Local Data Protection Privacy Notice

The controller for this project will be University College London (UCL). The UCL Data Protection Officer provides oversight of UCL activities involving the processing of personal data and can be contacted at data-protection@ucl.ac.uk**.**

This 'local' privacy notice sets out the information that applies to this study. Further information on how UCL uses participant information can be found in our 'general' privacy notice: https://www.ucl.ac.uk/legal-services/privacy/ucl-general-research-participant-privacy-notice.

The information that is required to be provided to participants under data protection legislation (GDPR and DPA 2018) is provided across both the 'local' and 'general' privacy notices.

The categories of personal data used will be as follows:
Age; Gender; Educational level; Former occupation (if applicable)
The lawful basis that would be used to process your personal data will be the performance of a task in the public interest.

Your personal data will be processed so long as it is required for the research project. We will endeavour to minimise the processing of personal data wherever possible. If you are concerned about how your personal data is being processed, or if you would like to contact us about your rights, please contact UCL in the first instance at data-protection@ucl.ac.uk.

12. Contact for further information

If you have any questions or require more information about this study, please contact me using the following contact details:
Mengxi Zhang (contact details removed)

You will be given a copy of the information sheet and a signed consent form to keep.
Thank you for reading this information sheet and for considering taking part in this research.

Appendix 3: Consent form

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Name and Contact Details of the Researcher:
Mengxi Zhang (contact details removed)
Name and Contact Details of the Supervisor:
Melanie Smallman (contact details removed)

Thank you for considering taking part in this research. The researcher must explain the project to you before you agree to take part. If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

I confirm that I understand that by ticking/initialling each box below I am consenting to this element of the study. I understand that it will be assumed that unticked/initialled boxes means that I DO NOT consent to that part of the study. I understand that by not giving consent for any one element that I may be deemed ineligible for the study.

		Tick Box
1	I confirm that I have read and understood the Information Sheet for the study. I have had an opportunity to consider the information and what will be expected of me. I have also had the opportunity to ask questions which have been answered to my satisfaction and would like to take part in the interview/focus group.	
2	I consent to participate in the study. I understand that my personal information (age, gender, educational level and former occupation) will be used for the purposes explained to me.	
3	I understand that all personal information will remain confidential and that all efforts will be made to ensure I cannot be identified. I understand that my data gathered in this study will be stored anonymously and securely. It will not be possible to identify me in any publications.	
4	I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason. I understand that if I decide to withdraw, any personal data I have provided up to that point will be deleted unless I agree otherwise.	

5	I understand the potential risks of participating and the support that will be available to me should I become distressed during the course of the research.	
6	I understand that the data will not be made available to any commercial organisations but is solely the responsibility of the researchers undertaking this study.	
8	I consent to my interview being audio recorded and understand that the recordings will be destroyed immediately following transcription. (If you do not want your participation recorded you can still take part in the study.)	
9	I am aware of who I should contact if I wish to lodge a complaint.	
10	I voluntarily agree to take part in this study.	

_____	_____	_____
Name of participant	Date	Signature
_____	_____	_____
Name of witness (If applicable)	Date	Signature
_____	_____	_____
Researcher	Date	Signature

*The recruitment information, participation information sheet and consent form for Chinese participants are in a similar form to the above but translated into Chinese.

Appendix 4: Table of participants

Group 1-1: Older people in China

	Age bracket	Gender	Educational level	Former occupation
1	60-64	M	Bachelor's degree	Civil servant
2	65-69	F	Bachelor's degree	Accountant
3	65-69	F	Senior high school	Designer
4	70-74	M	Technical secondary school	Accountant
5	85-89	M	Primary school	Factory worker
6	60-64	F	Bachelor's degree	Accountant
7	60-64	M	Junior high school	Salesman
8	75-79	M	Primary school	Auto mechanic
9	75-79	F	Primary school	Factory worker
10	60-64	F	College	Accountant
11	60-64	F	Bachelor's degree	Warehouse worker
12	70-74	F	Junior high school	Shopkeeper
13	70-74	M	Junior high school	Transportation & shopkeeper
14	60-64	F	Senior high school	Dressmaker
15	70-74	F	Primary school	Salesclerk
16	85-89	M	Primary school	Employee in a mining enterprise
17	75-79	F	Primary school	Unemployed
18	75-79	M	Technical secondary school	Teacher
19	75-79	F	Technical secondary school	Teacher & shop assistant
20	65-69	M	Junior high school	Employee in an electric power company
21	80-84	F	Uneducated	Chef
22	70-74	M	Primary school	Financial staff
23	70-74	F	Primary school	Factory worker
24	65-69	M	Senior high school	Accountant
25	60-64	F	Senior high school	Employee in a credit cooperative
26	70-74	M	Junior high school	Transportation
27	60-64	F	Senior high school	Financial staff
28	90-94	M	Primary school	Accountant
29	95-99	M	Primary school	Factory worker

30	60-64	F	Master's degree	Teacher

Group 1-2: Older people in the UK

	Age bracket	Gender	Educational level	Former occupation*
1	60-64	F	Master's degree	Education
2	70-74	F	Bachelor's degree	Tutor
3	75-79	F	Secondary school	Trader
4	65-69	M	Navy school	House husband & professional guard
5	60-64	F	College	Store sales
6	Slightly under 60	M	Uneducated	Unemployed
7	70-74	F	Bachelor's degree	Bookkeeper
8	65-69	M	College	Truck driver
9	65-69	M	Secondary school/ apprenticeship	Shop manager
10	80-84	M	Secondary school/ apprenticeship	Engineer
11	99+	M	Secondary school/ apprenticeship	Electrician
12	65-69	F	College	Shop assistant
13	75-79	M	Secondary school/ apprenticeship	Electrician
14	75-79	F	Secondary school	Cleaner
15	75-79	F	College	Shop assistant
16	60-64	F	Secondary school	Sales assistant
17	60-64	F	Secondary school	Support worker
18	60-64	M	BTEC level 1	Civil enforcement officer
19	70-74	F	Secondary school	Receptionist
20	70-74	F	College	Assistant accountant
21	65-69	F	Secondary school	Mechanist
22	Slightly under 60	F	Secondary school	Housewife
23	65-69	F	Secondary school	Hospitality
24	70-74	M	Bachelor's degree	Unspecified
25	60-64	M	Other	Government officer
26	60-64	M	Secondary school	Waiter barman
27	75-79	F	Secondary school	Care assistant

28	75-79	F	Secondary school	Shop assistant
29	Slightly under 60	M	Degree management studies	Civil servant
30	60-64	F	Secondary school	Supermarket checkouts

*The purpose of collecting occupational information is to diversify the association between occupation and technology. Personal health status is collected but not shown in the table to protect the privacy of participants.

Group 2: Caregivers

	Age bracket	**Gender**	**Role as caregiver**
1	40-44	F	Care home staff
2	30-34	F	Professional caregiver working at home
3	25-29	F	Living with grandparents
4	30-34	M	Living with parents
5	20-24	F	Living with grandparents
6	50+	F	Care home manager
7	45-49	F	Living with parents
8	25-29	M	Professional caregiver working in hospital
9	35-39	F	Staff in older people's community
10	50+	F	Staff in older people's community

Group 3: Technology workers

	Age bracket	**Gender**	**Role in company/ institute***
1	35-39	M	Developer
2	30-34	M	Researcher
3	25-29	F	Brand manager
4	25-29	F	Project manager
5	40-45	F	Innovator
6	25-29	F	UX researcher
7	30-35	F	Product designer
8	40-45	M	Developer
9	25-29	F	Product assistant
10	25-29	M	Developer

*To protect the privacy of the above participants, the type of health technology they work for is not disclosed.

Appendix 5: Interview guide

Group 1: Older people

1. Personal information
    a) Age/Gender/Educational level/Former occupation/Health status
    b) What are the biggest changes in your life over the past ten years? (What do you think about ageing and ageing policies?)
    c) What do you usually do in your daily lives? (Use of media, use of mobile phones, participation in social activities, etc.)
2. Health behaviour
    a) Do you exercise regularly? Do you have any habits related to health (e.g., dieting/sleeping/medication)?
    b) Have you needed or used care services in the past 3 months?
    c) Can you tell me your experience and feelings in these health-related behaviours?
3. Health technology acceptance
    a) What type of technology do you know or use? (Following question 2c if they mentioned technology) How do you use it?
    b) How has the technology impacted your life?
    c) What is your attitude towards the technology? Why do you adopt or reject the technology? What parts of the technology (and anything related to the technology) you like or dislike? (Past experience, access, cost, ease of use, usefulness, perception of ageing and health, perceived security, data considerations, appearance, etc., follow-up questions are asked according to their answers.)
    d) Are there anyone else (or any special events) involved in your acceptance of the technology? (Introduction, purchase, support, notice, despise, etc.) Is there any other kind of support do you need to use the technology?
4. Health technology participation
    a) Have you been involved in any activities related to the development of health technology? (If yes, how was that experience? Why did you participate? If no, why not?)
    b) Do you want to participate in the development of health technology?

c) What are your expectations of participation?
d) Do you have any concerns about participation?

5. Wrap-up questions
   a) What do you think of health technology in general (e.g., development, social impact, policies, etc.)?
   b) Do you have anything to add? / Do you have any other questions?

Group 2: Caregivers

1. Personal information
   a) Age/Gender/Educational level/Role as a caregiver
   b) What do you think of older people you provide care for? What kinds of care do you provide for older people?
   c) (For professional caregivers) How many years have you been in this position? What do you think of working with older people?
2. Older people and health technology
   a) Do older people you care for use any technology in health-related behaviours? How do you think of the technology and how do older people think of the technology from your perspective?
   b) In what aspects do the technology meet older people's requirements? What could be improved for older people?
   c) Have you ever had experience interacting with older people with the technology? (Introduction, help them set up or use, fix the problem of devices, etc.) Please give an example. (Why do they need the help?)
   d) (For professional caregivers) How do you deploy health technology in the care home/hospital/older people's community? How does the technology influence older people? (Does it provide general convenience, increase difficulties, or lead to unfairness for older people?)
3. Older people and health technology participation
   a) What do you think of older people participating in the development of health technology?
   b) What do you think you can do in older people's participation?
4. Wrap-up questions

a) What measures can be taken to further reconcile older adults with health technology? Which groups of people can play a role in this relationship and how?
b) Do you have anything to add? / Do you have any other questions?

Group 3: Technology workers

1. Personal information
   a) Age/Gender/Educational level/Role in company or institute
   b) How long have you been doing this work? Why did you choose this job?
2. Health technology
   a) Could you introduce the technology products you worked/are working for? What is it for?
   b) What is your role in the development/delivery of the health technology? What kind of team/colleagues are you working with? Can you tell me some special experience in working with them and working for the health technology?
   c) What do you think of health technology in general?
3. Health technology and older people
   a) Who are the target users of your products? To what extent do the product reach the target user?
   b) What do you think of older people and older people's acceptance of health technology? What can be the reasons older people adopt or reject your products?
   c) Has the technology been designed in consideration of older people? Are your products age-friendly, in what ways? (If no, what do you think are the main reasons?) Do you think it can be improved in any ways?
4. Older people's participation in health technology
   a) Does your company/institute incorporate public participation in the development of health technology? (If yes, what format of participation? Who are involved and how they are recruited? How does your company/institute deal with their feedback? If no, why not?) What do you think of participation?

b) Are older people involved in the development of health technology? (If yes, what format of participation? How are they recruited? What are the outcomes of participation? If no, why not?)
c) Is there a need to involve older people in health technology? Why and why not?

5. Wrap-up questions
   a) What measures can be taken to further reconcile older adults with health technology? Which groups of people can play a role in this relationship and how?
   b) Do you have anything to add? / Do you have any other questions?