Can Smart Home Technology Deliver on the Promise of Independent Living? A Critical Reflection Based on the Perspectives of Older Adults

Chapter · January 2015

DOI: 10.1007/978-3-319-01904-8_41-1

3 authors:

Sebastiaan T.M. Peek
Tilburg University
30 PUBLICATIONS **487** CITATIONS

SEE PROFILE

Sil Aarts
Maastricht University
44 PUBLICATIONS **318** CITATIONS

SEE PROFILE

Eveline J Wouters
Hogeschool Fontys
83 PUBLICATIONS **965** CITATIONS

SEE PROFILE

Handbook of Smart Homes, Health Care and Well-Being
DOI 10.1007/978-3-319-01904-8_41-1

Can Smart Home Technology Deliver on the Promise of Independent Living?

A Critical Reflection Based on the Perspectives of Older Adults

Sebastiaan T. M. Peek[a,b]*, Sil Aarts[a] and Eveline J. M. Wouters[a]
[a]Institute of Allied Health Professions, Chair of Health Innovations and Technology, Fontys University of Applied Sciences, Eindhoven, The Netherlands
[b]Department of Tranzo, School of Social and Behavioral Sciences, Tilburg University, Tilburg, The Netherlands

Abstract

Expectations are high with regards to smart home technology. In particular, smart home technology is expected to support or enable independent living by older adults. This raises the question: can smart home technology contribute to independent living, according to older adults themselves? This chapter aims to answer this question by reviewing and discussing older adults' perspectives on independence and their views on smart home technology. Firstly, older adults' opinions on independence and aging in place are discussed. Secondly, this chapter will review to what extent smart home technology can support older adults' independence. Thirdly, it will be explained how community-dwelling older adults' concept of independence entails three distinct types or modes, and how these modes are related to their perceptions and acceptance of technology. In the last section of this chapter, an overview of key points is presented, and recommendations for technology designers, policy makers, and care providers are postulated.

Keywords

Independence; Aging in place; Smart home technology; Technology acceptance; Design; Implementation

Introduction

The increase in longevity, the growing number of older adults, and the decreasing number of newborns denote that the populations of most countries in the world are aging rapidly (United Nations 2013). To date, Europe has the highest proportion of older people in the world. The increase in the proportion of older persons is primarily due to changes in health indicators including improved nutrition and hygiene (Evans et al. 1994). Furthermore, advances in both preventive and curative medicine have resulted in an increasingly large number of (older) patients that survive medical conditions that previously used to be fatal. Unfortunately, this does not imply that older adults are all in good health and well-being. For example, the majority of older adults (i.e., over 75 years of age) report having one, two, or more chronic conditions that they are suffering from (Aarts et al. 2012; Woo and Leung 2014). Since age is positively related to health care utilization and, in turn, to higher health care expenditure, the influence of aging populations on society will be marked (Schulz et al. 2014). Hence, the provision of cost-effective care solutions is asked for.

*Email: s.t.m.peek@tilburguniversity.edu
*Email: s.peek@fontys.n

Handbook of Smart Homes, Health Care and Well-Being
DOI 10.1007/978-3-319-01904-8_41-1

To anticipate on the growing demand on health care by older adults, governments and policy makers are trying to empower older persons in maintaining independence as long as possible. By enabling them to keep residing in their own homes, i.e., to age in place, costly options such as nursing homes can be avoided. Smart homes have been postulated as a potential solution to support aging in place. A smart home can be defined as "*a residence equipped with a high-tech network, linking sensors and domestic devices, appliances, and features that can be remotely monitored, accessed or controlled, and provide services that respond to the needs of its inhabitants*" (Balta-Ozkan et al. 2013). Several target groups could potentially benefit from smart home technology, one of them being older adults who would like to age in place. For example, smart homes technologies are aimed at supporting aging in place by facilitating tasks such as preparing food and cleaning. Furthermore, smart home technology can assist in monitoring and maintaining health status (Mitzner et al. 2010).

Despite the emphasis on smart homes by government agencies, policy makers, and the industry (Sixsmith and Sixsmith 2008), their existence is not widespread (Schulz et al. 2014; Wilson et al. 2014). Consequently, their suggested potential for older adults in promoting independence and aging in place, and thereby, alleviating pressure on (family) caregivers, and decreasing health care expenditure, has not yet reached its full potential. The question remains why smart home technologies are not yet commonplace in the homes of older people. The current chapter aims to answer this question by reviewing and discussing older adults' perspectives on independence and their views on smart home technology. In other words, can smart home technology deliver on the promise of independent living, according to this target group? This chapter will start by discussing older adults' opinions on aging in place and staying independent. Secondly, this chapter will discuss to what extent smart home technology can support older adults' independence. Subsequently, it will be explained how community-dwelling older adults' concept of independence entails three distinct types or modes, and how these modes are related to their perceptions and acceptance of technology. Lastly, implications and recommendations for technology designers, policy makers, and care providers are postulated.

Older Adults' Opinions on Living Independently

As older age is related to decreases in health, functional abilities, and social relations (Rowe and Kahn 1987, 1997), the home environment is the major living space of older people (Baltes et al. 1999). A study by Gillsjo and colleagues reported the views of older adults, living in a rural community in Sweden, on their experience of "home" (Gillsjö et al. 2011). This study pinpointed that home "*had become integral to living itself*" and was "*an intimate part of the older adult's being*" (Gillsjö et al. 2011). A study by Wiles and colleagues focused on the meaning of aging in place (Wiles et al. 2012). By conducting focus groups, the study illustrated that aging in place was perceived as an advantage in terms of security, familiarity, and people's sense of identity (Wiles et al. 2012). In general, research suggests that the majority of older persons want to keep living independently, in their current dwelling (Barrett 2011; Boldy et al. 2011; Woolhead et al. 2004).

Research also suggests that the desire to remain independent is influenced by a variety of factors including (self-perceived) health status and personal characteristics. For example, the desire to remain in one's current dwelling seems to increase with age (Boldy et al. 2011). Another study showed that, although older adults in general perceive being independent as very important, men were found to value independence as less important than women (Galenkamp et al. 2012). Functional status has also been suggested to influence the desire to remain independent. Being independent seems especially important to those with mild cognitive problems and/or depressive symptoms. However, older adults with severe functional limitations perceive independence as less important than older adults with no or

DOI 10.1007/978-3-319-01904-8_41-1

few functional limitations (Galenkamp et al. 2012). Galenkamp and colleagues (2012) suggest that older adults hold on to their independence up to a certain point; once their health deteriorates considerably, they seem to give up (part of) the desire to be independent in order to receive care. Similar findings are reported in a study by Allen and Wiles (2014) in which community-dwelling older adults stated that receiving informal support and using assistive technology was only considered acceptable when help was necessary due to health issues.

In summary, the abovementioned findings indicate that older people wish to remain independent but also highlight the fact that the desire to remain independent may differ per person and that this desire is influenced by factors like health status. As a consequence, older adults' opinions on (technological) solutions aimed at supporting aging in place may also vary. In this respect, it is important to review to what extent smart home technology can support older adults' ability to live independently.

The Influence of Smart Home Technology on the Ability to Live Independently

Many developments are taking place in the field of smart home technology, and expectations are high with regards to the potential benefits. Unfortunately, a recent published systematic review regarding smart home technology identified only three (out of 31) studies that effectively demonstrated that smart home technology can support independence and prevent health events that threaten the independence of older adults (Reeder et al. 2013). These three studies showed that the use of smart home technology was positively related to outcomes such as a reduced length of nursing home admissions (Kelly 2005), preservation of physical and cognitive status (Tomita et al. 2007), and improved social functioning (Brownsell et al. 2008)[1]. All three of studies were similar in that they included a combination of technologies tailored to individual preferences of the user, including activity monitoring technology, and other functionality such as medication reminders (Reeder et al. 2013). The other 28 studies that were included in the review did not demonstrate strong evidence of support for aging in place, mainly due to their study designs and sample size (for more information, see (Reeder et al. 2013)). Other systematic reviews also pinpoint that little methodically sound research is available on the effects and cost-effectiveness of smart home technology (Graybill et al. 2014; Peetoom et al. 2014). This raises the question: how can older adults be convinced to use smart home technology when benefits have not been demonstrated clearly in terms of scientific evidence? In this respect, it is important to consider to what extent older adults themselves perceive smart home technology as something that can help them to age in place.

A recent systematic review conducted by our research group showed that the vast majority of studies on community-dwelling older adults' perceptions on smart home technology are performed in the pre-implementation stage (when a technology has not been used yet). These studies typically include the use of presentations, vignettes, or scenarios to explain or demonstrate a technology to participants (Peek et al. 2014). Consequently, participants are asked about technology that they have not actually used and experienced for a considerable amount of time. In pre-implementation studies, community-dwelling older adults mention various concerns, when asked about their opinions on technology that is designed to support aging in place (Peek et al. 2014). Frequently mentioned concerns are high cost and privacy

[1]Reeder et al. (2013) classified studies as "emerging," "promising," "effective (first tier)," or "effective (second tier)." The three studies mentioned were not considered "effective (second tier)" by Reeder et al. (2013) because they were limited by the use of a historical control group (Kelly 2005), high dropout rates (Tomita et al. 2007), and the use of nonrandomized comparison groups (Brownsell et al. 2008). None of the studies included in the review by Reeder et al. (2013) were classified as the highest type of evidence, which was "effective (second tier)."

DOI 10.1007/978-3-319-01904-8_41-1

implications. Additionally, a number of the mentioned concerns are related to usability; community-dwelling older adults may think that smart home technologies are hard or impractical to use. Furthermore, older adults may be concerned that they have no control over the technology, for instance, its activation and deactivation. Participants in pre-implementation studies also express concerns regarding the burden it may put on their children in their role as caregivers (i.e., causing workload or worrying) and the possible negative effects on their personal health. Moreover, community-dwelling older adults express concerns that smart home technology may be too noticeable or obtrusive within their homes. Older adults can also be worried that they can be considered "frail" or "old" once they are seen using technology that is specifically designed for frail older adults. This fear of stigmatization can be very powerful (Cohen-Mansfield 2005; Lee and Coughlin 2014; Peek et al. 2014; Rush et al. 2013; Steele et al. 2009).

While community-dwelling older adults may have concerns regarding smart home technology, they also see benefits, such as increased independence and increased safety (Peek et al. 2014). However, these perceived benefits do not "automatically" translate in acceptance of smart home technology. This is illustrated in a recent pre-implementation study conducted by Claes and colleagues (2014) that investigated beliefs regarding contactless sensors. These sensors enable tracking of older adults' personal safety, their health status, and their ability to perform activities of daily living. According to the vast majority of the participants in this study, contactless sensors were indeed useful to age in place, both safely and independently. In sharp contrast, only a minority of respondents was willing to accept contactless monitoring at this point in their life (15.5 %). The willingness to accept the technology later in life (82.4 %), or in the case of health decline (91.8 %), was remarkably higher (Claes et al. 2014). These results are prototypical for pre-implementation studies on technology acceptance: older adults think that smart home technology is not necessarily intended from them, but rather for other, less healthy older people (Peek et al. 2014). This is in congruence with older adults' positive perception of their personal health, despite a decline in their objective health status (Cheng et al. 2007; Pinquart 2001).

To date, studies conducted in the post-implementation stage, when community-dwelling older adults have used and experienced a certain technology, are scarce (Peek et al. 2014). One example of a post-implementation study was conducted by van Hoof and colleagues (2011). In this study, interviews were conducted with 18 community-dwelling older adults with a complex demand for care. The participants of this study agreed to have an unobtrusive monitoring system installed in their homes, mostly because they wanted to improve their sense of safety and security and because they wanted to age in place. These participants reported an increased sense of safety and security in the post-implementation stage. Similar findings are reported in a post-implementation study by Pol and colleagues (2014). However, Pol and colleagues (2014) note that, similar to the study by van Hoof and colleagues (2011), "*participants were all old aged and experienced some age- and health-related limitations in their daily functioning*" and that "*they were aware of their vulnerability and expressed a need for strategies to maintain independent living*." Pol and colleagues (2014) argue that these circumstances led to the acceptance of the sensor monitoring system by participants and that research is needed to investigate whether older people who do not express or acknowledge their own vulnerability are also prone to accept smart home technology. The latter seems particularly important considering the fact that smart home technology is frequently postulated to play an important role in preventing functional decline of relatively healthy older individuals (Eriksson and Timpka 2002).

All in all, the abovementioned findings lead to a somewhat puzzling conclusion: many older adults have the desire to age in place, and many older adults also believe that smart home technology can contribute to independent living, yet these conditions often do not translate into a willingness to accept smart home technology. Only older adults who see that they may be at risk of losing their ability to live independently seem to be willing to accept smart home technology. It has been argued that a clear understanding of the motives of (potential) users of smart home technology is lacking in the current

DOI 10.1007/978-3-319-01904-8_41-1

literature (Wilson et al. 2014). Therefore, the next paragraph will look more detailed at older adults' concept of independence and its relation to perceptions and acceptance of technology.

Different Types of Independence and Their Relations to Acceptance of Technology

Independence is commonly regarded as the ability to live without relying on external help, being the opposite of dependence (Fine and Glendinning 2005). However, in an important contribution, Sixsmith (1986) showed that the concept of independence, as perceived by community-dwelling older adults, entails three specific modes or types. First, independence can imply being able to look after oneself, not being dependent on others. Second, independence can refer to self-direction, the freedom to do what you want to do. Third, independence can mean not feeling obligated to someone, e.g., family members or caregivers (Sixsmith 1986). The first mode, being able to look after oneself, is the type of independence that policy makers aim for, and suppliers of smart home technology intent to support. Unfortunately, the other two modes of independence, although also important to older adults (Sixsmith 1986), are often ignored in the design and implementation of smart home technology. In a longitudinal qualitative field study, which our research group has been conducting since 2012, several ways in which these different modes of independence can play a role in the acceptance of technology by community-dwelling older adults have been observed (Peek et al. 2012). In this study, 50 community-dwelling participants (with a minimum age of 70) are visited in their own dwelling, every 8 months within a period of 4 years. The aim of this study is to explore and describe factors and mechanisms which influence the level of use of various types of technology (including household appliances, ICT, telephones, means of transport, and assistive technology) that are present in the homes of participants. In addition, the participants are asked to what extent they feel that technology can aid them in looking after themselves (the first mode of independence). Preliminary findings of our study indicate that, according to participants, assistive technology and means of transport (i.e., a car or an electric bike) can be important for maintaining this mode of independence. However, our findings also indicate that there is considerable amount of variation; while some participants state that assistive technology helps them to look after themselves, others indicate that they would rather do things themselves (i.e., without relying on technology): "*we are still stubborn in a sense that we do everything ourselves*".

Regarding the second mode of independence (the freedom to do what you want to do), older adults in our study report that certain types of technology can both support and threaten this type of independence. One example of this is the use of mobile phones. On the one hand, mobile communication technology provides participants with a sense of security, knowing that they can reach someone in case of emergency and thereby facilitating them in leaving their homes and performing activities. On the other hand, carrying a mobile phone also leaves participants open to interference by others (e.g., family members who can call participants whenever they feel they need to). This interference can lead to a feeling of "*not being able to do what you want to do*." A similar ambivalence occurs when older adults are using hearing aids. Hearing aids can have an empowering effect because they enable older adults to hear and respond to stimuli (i.e., sounds) that they would otherwise be unaware of. This enables them to engage in more activities and social interactions. However, at the same time, using a hearing aid can also lead to the avoidance of social activities such as birthday parties, due to overstimulation (i.e., hearing too much sound when many people are present). With both abovementioned types of technology, this ambivalence can lead to older adults using technology selectively: "*I only take it with me when I feel that I might be needing it*".

Looking at the third mode of independence (not feeling obligated to someone), participants in our study frequently mention that they do not want to be a burden to others, particularly family members. For

DOI 10.1007/978-3-319-01904-8_41-1

example, participants in our study mention that they want to avoid asking their children to help them in using ICT devices or are afraid to cause false alarms while wearing a personal alarm button. Again, these situations can cause older adults to not fully make use of certain types of technology.

The aforementioned issues are not exclusive to technology such as mobile phones or hearing aids. Studies investigating acceptance of smart home technology also point to problems that seem to be related to perceptions of independence. For instance, Boström and colleagues (2013) have shown how monitoring technology can impact older adults' perceptions of Sixsmiths' (1986) second mode of independence (the freedom to do what you want to do). Their research shows that community-dwelling older adults can fear that monitoring technology could "take over" or "take control" of their lives. Other studies have also shown that community-dwelling older adults prefer to be in control of smart home technology instead of the other way around (Steele et al. 2009; van Hoof et al. 2011). Interference of technology with personal freedom may also occur in the case of lifestyle monitoring technology, which is designed to promote a healthy lifestyle by giving the user visual or auditory reminders and cues that are designed to influence the users' behavior. These reminders and cues may be perceived as meddlesome by users.

Privacy issues are another example of how acceptance of smart home technology can be influenced by perceptions of different modes of independence. Studies have shown that technologies that enable the sharing of personal information to formal and informal caregivers can be seen by community-dwelling older persons as something that enables them to stay in their current dwelling (Boström et al. 2013; Lorenzen-Huber et al. 2010; Wild et al. 2008). In other words, they perceive that technology can have a favorable influence on the ability to look after oneself (Sixsmiths' first mode of independence). In addition, while some studies have shown that older adults feel that the aforementioned technologies can reduce the burden on caregivers (Boström et al. 2013; Lorenzen-Huber et al. 2010), others have shown that older adults are worried that these technologies actually might increase the burden of caregivers (Steggell et al. 2010; Wild et al. 2008). This outlines that to older adults, smart home technology can both positively and negatively influence the feeling of being obligated to someone (Sixsmiths' third mode of independence).

The examples mentioned in this paragraph pinpoint that several of older adults' perceived favorable and unfavorable consequences of using technology in the context of aging in place can be framed in terms of how technology affects three distinct modes of independence. The findings in this paragraph also show that community-dwelling older adults can feel good and bad about a certain technology, rather than just good or bad (Boström et al. 2013).

Implications for the Design and Implementation of Smart Home Technology

In this chapter, we have reviewed and discussed older adults' perspectives on their independence and their views on smart home technology. The following key points were made:

- In general, older adults want to live independently in their current dwelling. However, the desire to live independently differs per person and is influenced by factors such as health status, age, and gender.
- Scientific evidence for the effectiveness of smart home technology in enabling independent living is scarce.
- Older adults who are not using smart home technology feel that it could support independent living, although they also express various concerns. They also perceive that smart home technology is not intended for themselves, but rather for other older persons who are less healthy.
- The concept of independence in the eyes of community-dwelling older adults entails three specific modes or types: (1) being able to look after oneself, not being dependent on others; (2) self-direction,

DOI 10.1007/978-3-319-01904-8_41-1

the freedom to do what you want to do; and (3) not feeling obligated to someone. It is important to realize that smart home technology can affect all of these three modes of independence, often simultaneously.

The abovementioned notions have several implications for the design and implementation of smart home technology. Firstly, technology suppliers, caregivers, and policy makers are advised to take a broad view of the concept of independence. While empowering older adults to be able to look after themselves is an important goal of smart home technology, it is also important to realize that smart home technology can, unfavorably, influence older adults' perceived personal freedom and feelings of obligation toward others. These aspects need to be taken into account in order to increase acceptance. This can be achieved by being sensitive to issues related to user control and implications of the technology for social relationships. For instance, one must be careful not to take too much control away from older users, since this may conflict with their concept of independence. In the same way, one should be aware of the fact that social relationships between older users and their social network are influenced by technology. Of particular importance is the relation between family members and older adults, which older adults prefer to keep asymmetrical: they like to "give" more than they "take" (Lindley et al. 2008). Smart home technology that is not designed and implemented in line with this "preference for asymmetry" may threaten older adults' concept of independence. The aforementioned broad view of independence could also benefit (cost-) effectiveness studies on smart home technology. Currently, effectiveness studies have a tendency to focus on measuring outcomes in line with a narrow definition of independence: the ability to look after oneself. Broadening this definition by including all modes of independence as described by Sixsmith (1986) may result in a more comprehensive understanding of the effects of the use of smart home technology on the lives of community-dwelling older adults.

Secondly, the key points made in this chapter implicate that technology suppliers, caregivers, and policy makers need to be sensitive to issues regarding diversification and timing. It is important to realize that older adults' perception of independence and their use of smart home technology may not only vary from person to person but may also vary across time. Moreover, older adults can have different opinions on each of three modes of independence. This complicates both the design and the implementation of smart home technology. Ideally, a smart home technology would be able to adapt itself to different and/or changing independence-related needs of older adults. To our knowledge, such a technology does not currently exist and is very challenging to design, build, and bring to the market. One of the more difficult aspects of such "self-adaptive technology" would be the design of algorithms to identify and monitor the user's independence-related needs. A more feasible alternative might be to let caregivers or care consultants who are in close contact with the older person identify and monitor their needs. These identified needs should subsequently be matched with suitable smart home technologies that are available on the market. However, this would require that the particular caregiver or care consultant would have a comprehension of (psychological) aspects of aging as well as technical developments. Professionals with this skillset may be scarce and training them might be expensive. Researchers can play a role here, by developing and validating tools (e.g., interview techniques, checklists) that allow individuals to identify and monitor older adults' needs and by developing methods that can facilitate the matching of these needs with technologies.

An underlying cause of the issues raised in this chapter may be that technology designers and older adults have different perspectives regarding the concept of independence. Other authors pinpointed that many designers typically have little understanding of the unique needs of older adults (Doyle et al. 2014; Neven 2010; Wilson et al. 2014). This may be caused by the fact that technology designers are usually considerably younger than older adults, which means that they may be unfamiliar with (psychological) aspects of aging and grew up using other types of technology in comparison to older adults. To overcome

DOI 10.1007/978-3-319-01904-8_41-1

this discrepancy, designers need to come into contact with older adults, preferably starting during their education.

Our goal of this chapter was not to provide an extensive overview of all factors involved in the acceptance of smart home technology. Instead, we have looked at the heart of the matter: can smart home technology deliver on the promise of independent living? At this point in time, we are inclined to answering this question unfavorably. This chapter also shows that the number of studies on older adults' perceptions of their independence in relation to smart home technology is limited. Additionally, a recent content analysis of industry-produced smart home marketing materials revealed "*a notable absence of user focused research*" (Hargreaves and Wilson 2013; Wilson et al. 2014). In our opinion, the way forward is to deepen our understanding of the (potential) needs and preferences of older people. In this way, the promising industry of smart home technology can make an important contribution to the independence of older adults.

References

Aarts S, van den Akker M, Bosma H et al (2012) The effect of multimorbidity on health related functioning: temporary or persistent? Results from a longitudinal cohort study. J Psychosom Res 73:211–217

Allen RES, Wiles JL (2014) Receiving support when older: what makes it ok? Gerontologist 54:670–682

Balta-Ozkan N, Davidson R, Bicket M, Whitmarsh L (2013) The development of smart homes market in the UK. Energy 60:361–372

Baltes MM, Maas I, Wilms HU et al (1999) Everyday competence in old and very old age: theoretical considerations and empirical findings. In: Baltes PB, Mayer UK (eds) Berlin aging study aging from 70 to 100. Cambridge University Press, Cambridge, pp 384–402

Barrett LL (2011) Healthy @ Home 2.0. Available via AARP. http://www.aarp.org/relationships/caregiving/info-03-2008/healthy_home.html. Accessed 10 Nov 2014

Boldy D, Grenade L, Lewin G et al (2011) Older people's decisions regarding "ageing in place": a Western Australian case study. Australas J Ageing 30:136–142

Boström M, Kjellström S, Björklund A (2013) Older persons have ambivalent feelings about the use of monitoring technologies. Technol Disabil 25:117–125

Brownsell S, Blackburn S, Hawley MS (2008) An evaluation of second and third generation telecare services in older people's housing. J Telemed Telecare 14:8–12

Cheng S-T, Fung H, Chan A (2007) Maintaining self-rated health through social comparison in old age. J Gerontol Ser B Psychol Sci Soc Sci 62:277–285

Claes V, Devriendt E, Tournoy J, Milisen K (2014) Attitudes and perceptions of adults of 60 years and older towards in-home monitoring of the activities of daily living with contactless sensors: an explorative study. Int J Nurs Stud 52:134–148

Cohen-Mansfield J (2005) Electronic memory aids for community-dwelling elderly persons: attitudes, preferences, and potential utilization. J Appl Gerontol 24:3–20

Doyle J, Bailey C, Ni Scanaill C, van den Berg F (2014) Lessons learned in deploying independent living technologies to older adults' homes. Univ Access Inf Soc 13:191–204

Eriksson H, Timpka T (2002) The potential of smart homes for injury prevention among the elderly. Inj Control Saf Promot 9:127–131

Evans RG, Barer ML, Marmor TR (1994) Why are some people healthy and others not? The determinants of health populations. Walter de Gruyter, New York

Fine M, Glendinning C (2005) Dependence, independence or inter-dependence? Revisiting the concepts of "care" and "dependency". Ageing Soc 25:601–621

Galenkamp H, Plaisier I, Huisman M, et al (2012) Trends in gezondheid en het belang van zelfredzaamheid bij zelfstandig wonende ouderen. Available via RVZ. http://www.rvz.net/publicaties/bekijk/trends-in-gezondheid-en-het-belang-van-zelfredzaamheid-bij-zelfstandig-wone. Accessed 10 Nov 2014

Gillsjö C, Schwartz-Barcott D, von Post I (2011) Home: the place the older adult cannot imagine living without. BMC Geriatr 11:1–10

Graybill EM, Mcmeekin P, Wildman J (2014) Can aging in place be cost effective ? A systematic review. PLoS One 9:1–6

Hargreaves T, Wilson C (2013) Who uses smart home technologies ? Representations of users by the smart home industry. Paper presented at the European Council for an Energy Efficient Economy (ECEEE) 2013 summer study, Toulon/Hyères, France, June 2013

Kelly D (2005) Smart support at home: the integration of telecare technology with primary and community care systems. Br J Healthc Comput Inf Manag 22:19–21

Lee C, Coughlin JF (2014) PERSPECTIVE: older adults' adoption of technology: an integrated approach to identifying determinants and barriers. J Prod Innov Manag. doi:10.1111/jpim.12176

Lindley S, Harper R, Sellen A (2008) Designing for elders: exploring the complexity of relationships in later life. In: England D (ed) BCS-HCI '08 proceedings of the 22nd British HCI group annual conference on people and computers: culture, creativity, interaction – vol 1. British Computer Society, Swinton, pp 77–86

Lorenzen-Huber L, Boutain M, Camp LJ et al (2010) Privacy, technology, and aging: a proposed framework. Ageing Int 36:232–252

Mitzner T, Boron J, Fausset C (2010) Older adults talk technology: technology usage and attitudes. Comput Hum Behav 26:1710–1721

Neven L (2010) "But obviously not for me": robots, laboratories and the defiant identity of elder test users. Sociol Health Illn 32:335–347

Peek STM, Wouters EJM, van Hoof J, et al (2012) Research on the sustained use of technology to support aging in place by community dwelling older adults. Paper presented at the Ambient Assististed Living Forum, Eindhoven, Sept 2012

Peek STM, Wouters EJM, van Hoof J et al (2014) Factors influencing acceptance of technology for aging in place: a systematic review. Int J Med Inform 83:235–248

Peetoom KKB, Lexis MAS, Joore M, et al (2014) Literature review on monitoring technologies and their outcomes in independently living elderly people. Disabil Rehabil Assist Technol 1–24 doi:10.3109/17483107.2014.961179

Pinquart M (2001) Correlates of subjective health in older adults: a meta-analysis. Psychol Aging 16:414–426

Pol M, van Nes F, van Hartingsveldt M, et al (2014) Older people's perspectives regarding the use of sensor monitoring in their home. doi: 10.1093/geront/gnu104

Reeder B, Meyer E, Lazar A et al (2013) Framing the evidence for health smart homes and home-based consumer health technologies as a public health intervention for independent aging: a systematic review. Int J Med Inform 82:565–579

Rowe JW, Kahn RL (1987) Human aging: usual and successful. Science 237:143–149

Rowe JW, Kahn RL (1997) Successful aging. Gerontologist 37:433–440

Rush KL, Watts WE, Stanbury J (2013) Older adults' perceptions of weakness and ageing. Int J Older People Nurs 8:1–9

DOI 10.1007/978-3-319-01904-8_41-1

Schulz R, Wahl H-W, Matthews JT et al (2014) Advancing the aging and technology agenda in gerontology. Gerontologist. doi:10.1093/geront/gnu071

Sixsmith A (1986) Independence and home in later life. In: Phillipson C, Bernard M, Strang P (eds) Dependency and interdependency in old age: theoretical perspectives and policy alternatives. Croom Helm, London, pp 338–348

Sixsmith A, Sixsmith J (2008) Ageing in place in the United Kingdom. Ageing Int 32:219–235

Steele R, Lo A, Secombe C, Kuen Y (2009) Elderly persons' perception and acceptance of using wireless sensor networks to assist healthcare. Int J Med Inform 78:788–801

Steggell CD, Hooker K, Bowman S et al (2010) The role of technology for healthy aging among Korean and Hispanic women in the United States: a pilot study. Gerontechnology 9:433–449

Tomita MR, Mann WC, Stanton K, Tomita AD (2007) Use of currently available smart home technology by frail elders process and outcomes. Top Geriatr Rehabil 23:24–34

United Nations (2013) World population ageing 2013. Available via United Nations. http://www.un.org/en/development/desa/population/publications/ageing/WorldPopulationAgeingReport2013.shtml. Accessed 10 Nov 2014

Van Hoof J, Kort HSM, Rutten PGS, Duijnstee MSH (2011) Ageing-in-place with the use of ambient intelligence technology: perspectives of older users. Int J Med Inform 80:310–331

Wild K, Boise L, Lundell J, Foucek A (2008) Unobtrusive in-home monitoring of cognitive and physical health: reactions and perceptions of older adults. J Appl Gerontol 27:181–200

Wiles JL, Leibing A, Guberman N et al (2012) The meaning of "aging in place" to older people. Gerontologist 52:357–366

Wilson C, Hargreaves T, Hauxwell-Baldwin R (2014) Smart homes and their users: a systematic analysis and key challenges. Pers Ubiquitous Comput 19(2):463–476

Woo J, Leung J (2014) Multi-morbidity, dependency, and frailty singly or in combination have different impact on health outcomes. Age 36:923–931

Woolhead G, Calnan M, Dieppe P, Tadd W (2004) Dignity in older age: what do older people in the United Kingdom think? Age Ageing 33:165–170