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## BARRIERS AND FACILITATORS OF OLDER PEOPLE'S mHEALTH USAGE: A QUALITATIVE REVIEW OF OLDER PEOPLE'S VIEWS

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**Abstract:** *The aim of this qualitative evidence synthesis is to identify and assess existing evidence on barriers to and facilitators of older people's usage of mHealth. Existing literature identified many factors that affect people's experiences and perceptions of mHealth, which are in turn influenced by their personal circumstances and biography. The following themes were identified using the thematic synthesis approach: (a) perception of usefulness, (b) user requirements, (c) self-efficacy, (d) sense of self and control, (e) privacy and confidentiality, and (f) cost. MHealth devices and services are complex interventions that have to be integrated into an older person's life in order to facilitate effective use. Developers, providers, and policymakers should make sure that older people are included in decisions about technology use and, further, should question whether the current promotion of technology as a panacea for societal and budgetary problems is rooted in a realistic assessment of their use in practice.*

**Keywords:** *older people, mHealth, user perspectives, technology acceptance, barriers and facilitators, qualitative evidence synthesis.*

## INTRODUCTION

The world's population is aging. By 2020, more people will be aged 60 or older than 5 or younger (World Health Organization [WHO], 2015). The likelihood of needing lengthy and complex health and social care rises with increasing age. This brings serious implications to the funding, quality, and organization of health- and social care systems, many of which are already under pressure due to lack of personnel and financial resources (Nilsen, 2015; WHO, 2011). Technology is seen as a way of increasing access to services, decentralizing care, and empowering patients to manage their own conditions, thereby reducing health-care expenditure and improving patients' quality of life (Free et al., 2013; Varshney, 2014). Thanks to the advancements in mobile technologies, many of the functions that have traditionally been dependent on home-based control units or other nonportable devices can now be integrated into mobile devices and freed from spatial or temporal restrictions (Free et al., 2013). The increasing popularity, capabilities, and affordability of modern mobile devices, such as smartphones, smartwatches, or tablet PCs, make them very attractive tools for health-care delivery (Free et al., 2013; Shahrokni, Mahmoudzadeh, Saeedi, & Ghasemzadeh, 2015).

WHO (2011, p. 6) defined mHealth as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless device." Free et al. (2013, p. 2) described it as "the use of mobile computing and communication technologies in health care and public health," and Varshney (2014, p. 20) stated that the purpose of mHealth is to provide "healthcare to anyone, anytime, and anywhere by removing locational and temporal constraints while increasing both the coverage and the quality of healthcare." These definitions are vague by necessity due to the rapid development of hardware and software capabilities and the seemingly infinite possibilities for their application. In this study, we define mHealth as the delivery of health and care services via mobile devices. A device is considered mobile if it is portable (i.e., can easily be carried in a small bag) or wearable.

Gokalp and Clarke (2013) indicated several tasks mHealth can fulfill in the care of older people:

- Devices can be used to monitor vital functions and disease patterns and communicate with health- or social care professionals (HCPs). These functions are traditionally referred to as telehealth, telemonitoring, or telemedicine (see also Cook et al., 2016; Pecina et al., 2011).
- Wireless sensors can detect falls or changes in motion patterns or routines, as well as the use of objects like medication dispensers, also referred to as telemonitoring (see also Horton, 2008).
- Alarms can be used to help older people live safely in their homes and to actively call for help in case of falls or other emergencies, a system also known as telecare (see also Barlow, Singh, Bayer, & Curry, 2007; Turner & McGee-Lennon, 2013).

Additionally, a growing range of software applications ("apps") for smartphones or tablet PCs are being developed to help people modify unhealthy behavior (e.g., smoking cessation apps) or actively manage their health (e.g., apps for diabetes or chronic obstructive pulmonary disease management; Varshney, 2014). The intention behind such apps is to provide these functions in the comfort of the home and to save older people the effort of having to travel,

sometimes far distances, to see HCPs (Call et al., 2015). Currently, the boundaries of what technology can achieve are being pushed ever further with new areas of application discovered continuously (Istepanian & Lacal, 2003; Kumar, Singh, & Mohan, 2010; Silva, Rodrigues, de la Torre Díez, López-Coronado, & Saleem, 2015). As most of these technologies and applications are still in their infancy, further expansion of mHealth can be expected in the years to come.

However, despite the hopes that mHealth can improve access and quality of health care while simultaneously reducing cost, little is yet known whether it can actually achieve these goals in practice (Barlow et al., 2007; Free et al., 2013; Shahrokni et al., 2015; Vesel, Hipgrave, Dowden, & Kariuki, 2015). Reasons for that concern include a tendency of technology designers to focus on usability of interventions rather than actual health outcomes; a lack of standardized, replicable study designs; and an absence of frameworks for evaluation (Labrique, Vasudevan, Kochi, Fabricant, & Mehl, 2013; Vesel et al., 2015). Furthermore, Vesel et al. (2015) stated that it is essential to address issues of technology acceptance to ensure successful implementation of mHealth programs.

Technology acceptance is an important matter in regard to older people's adoption of mHealth, not least because it appears that the overall uptake of technology for health-related purposes is low in this age cohort (Turner & McGee-Lennon, 2013). According to Smith (2014), people over the age of 65 generally use fewer new technologies—including the Internet, smartphones, and other digital devices—and use them less frequently than younger people. Older, less educated, and less affluent people, as well as people with disabilities, appear to use them even less often (Smith, 2014). This phenomenon is commonly referred to as the digital divide (Brodie et al., 2000). However, as Parker, Jessel, Richardson, and Reid (2013) pointed out, older people are the fastest growing group in terms of new users. To develop technologies that address older people's health needs and support their autonomy—and which also are widely accepted, adopted, and utilized—it is essential to understand older people's experiences, expectations, and concerns.

As of yet, very little research directly addresses issues that influence older people's decisions to adopt mHealth. A majority of studies referring to mHealth in their title or abstract are effectiveness or feasibility studies; another sizable group addresses HCPs, especially in low- or middle-income countries. As highlighted earlier, aspects of mHealth also are known under different names, including telehealth, telecare, or telemonitoring. By using these terms, it is possible to identify a slightly larger number of studies that concerned, firstly, older people's perceptions and experiences of technology for health- and social care purposes and, secondly, what influences their decisions on whether and how to use them. Even though these studies do not explicitly talk about mHealth, the technology used is often wearable or portable and can thus be referred to as mobile. The aim of the present research is to identify and assess evidence on barriers to or facilitators in older people's usage and their expectations and requirements concerning mHealth.

## METHODOLOGY

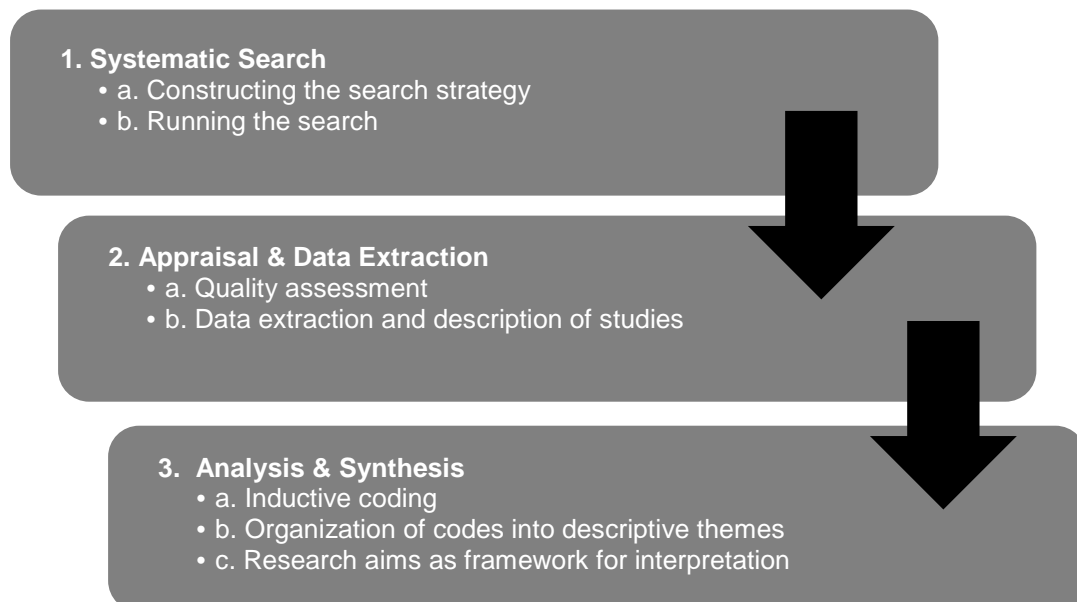
Qualitative methods are uniquely suited to exploring people's experiences and expectations on phenomena and products and for providing explanations as to why, how, and for whom certain interventions are effective (Atkins et al., 2008; Thomas & Harden, 2008). Thematic synthesis,

developed and described by Thomas and Harden (2008), is one of a number of emerging methods to synthesize findings from qualitative studies (Barnett-Page & Thomas, 2009). It combines components of traditional systematic reviews and methods for analyzing primary qualitative research with the aim of providing insight into people's acceptance, need, and experiences of health promotion and public health interventions. It thus can be used to generate hypotheses against which findings of quantitative studies concerned with intervention effectiveness can be tested (Thomas & Harden, 2008). The main steps of the thematic synthesis are illustrated in Figure 1.

## Systematic Search

### Constructing the Search Strategy

In this study, the initial search strategy was devised by the first author and discussed and advanced by both authors. We used the SPIDER (Sample, Phenomenon of Interest, Design, Evaluation and Research type) tool, developed by Cooke, Smith, and Booth (2012), to construct the search. We generated key terms to capture mHealth from studies identified in an initial scoping search. Where appropriate, we used thesaurus terms or subject headings and supplemented them with free-text keywords, which we combined using the Boolean operator "OR." We employed a similar strategy for each of the individual SPIDER elements, which we then combined via "AND." After a test run using MEDLINE, we decided to omit the Evaluation element as it yielded no further eligible studies but increased the number of articles to be screened almost threefold. The SPIDER search elements can be found in Table 1. Appendix A displays the finalized search strategy with the keywords that were used for the search.



**Figure 1.** The main steps of thematic synthesis according to Thomas and Harden (2008).

**Table 1.** SPIDER Elements and Eligibility Criteria.

<b>SPIDER elements</b>	<b>Eligibility criteria</b>
<b>Sample:</b> "Older people"	<p><b>Included:</b></p> <ul style="list-style-type: none"> <li>No restrictions in terms of age of participants as long as the mean is above 60</li> <li>No limitations in terms of living arrangements, health status, or cognitive abilities</li> </ul> <p><b>Excluded:</b></p> <ul style="list-style-type: none"> <li>Studies focusing on management of mental health and palliative care</li> <li>Studies that include other stakeholders (e.g., health- and social care professionals = HCPs, caregivers, mHealth providers) if their individual contributions cannot be discerned</li> </ul>
<b>Phenomenon of Interest:</b> "mHealth"	<p><b>Included:</b></p> <ul style="list-style-type: none"> <li>Digital/electronic technologies that are mobile, i.e., portable or wearable, even if not specifically referred to as mHealth</li> </ul> <p><b>Excluded:</b></p> <ul style="list-style-type: none"> <li>Nonportable or wearable technology used for health or care delivery, i.e., landline telephones, TVs, PCs/Laptops, or robots</li> <li>Technology for other purposes than (self-) care and health/disease management for older people</li> <li>Technology for acute conditions or short-term care (e.g., postoperative care after discharge from hospital)</li> </ul>
<b>Design</b>	<p><b>Included:</b></p> <ul style="list-style-type: none"> <li>Qualitative data generation methods</li> </ul> <p><b>Excluded:</b></p> <ul style="list-style-type: none"> <li>Effectiveness and feasibility studies</li> <li>Pilot studies if they do not contain qualitative elements</li> </ul>
<b>Evaluation</b>	<p><b>Included:</b></p> <ul style="list-style-type: none"> <li>All older people's experiences and views concerning mHealth, irrespective of their current or previous use or decision not to use</li> </ul>
<b>Research type</b>	<p><b>Included:</b></p> <ul style="list-style-type: none"> <li>Qualitative or mixed-methods studies</li> </ul> <p><b>Excluded:</b></p> <ul style="list-style-type: none"> <li>Quantitative studies such as randomized controlled trials or surveys</li> </ul>

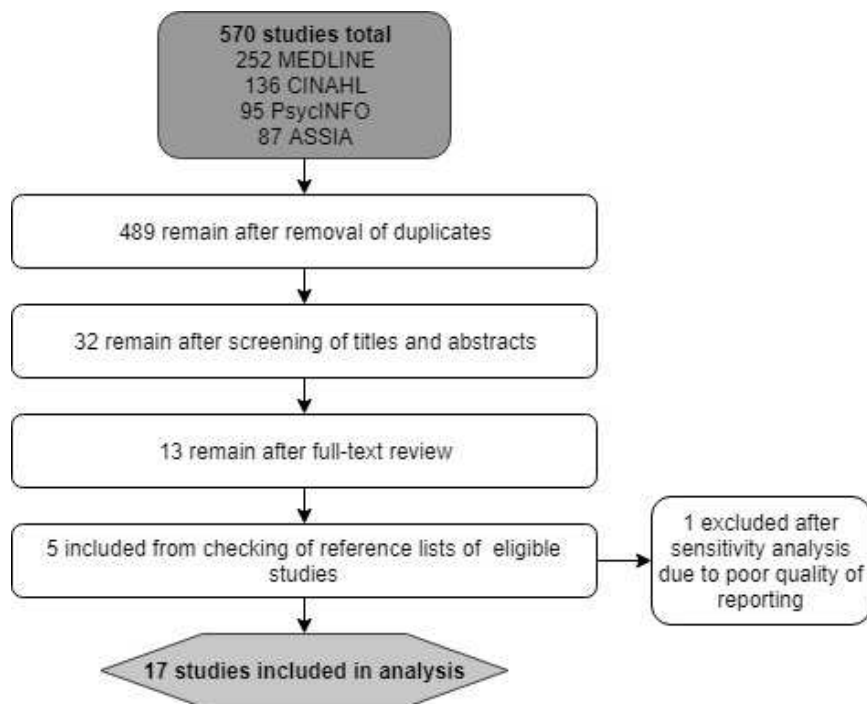
## Running the Search

The databases MEDLINE, CINAHL, ASSIA and PsycINFO were searched by the first author for studies published in English between January 1, 2007 and June 15, 2017, the day on which the search was carried out. This date restriction was chosen because the introduction of the first iPhone in 2007<sup>1</sup> led to dramatic developments in what mobile technology can do and in the way people use and integrate it into their lives (Hern, 2017; Lupton, 2013; Silva et al., 2015). MEDLINE was chosen for its focus on biomedical literature. CINAHL is a database for literature on nursing and allied disciplines. ASSIA indexes sociological literature, and PsycINFO lists content from psychology. The 570 thus identified studies were inputted into EndNote X7 referencing software. The first author then screened the titles and abstracts of the 489 studies remaining after elimination of duplicates for their relevance according to the predefined eligibility criteria, presented in Table 1. After this review, only 32 papers remained with titles/abstracts that met the criteria.

The first author then retrieved and carefully read the full texts of the 32 articles, after which just 13 eligible studies remained. The author checked the reference lists of these 13 papers to identify any potentially valuable studies that may have been missed in the systematic search. This yielded 5 additional articles meeting the criteria. A total of 18 articles were found to be appropriate to continue into the next stage, quality assessment, although subsequently one was eliminated because of problematic reporting. This left 17 studies for the analysis and synthesis phase. The search process is illustrated in Figure 2. An overview of the included studies can be found in Table 2.

### Data Extraction and Description of Studies

We created a data extraction tool to capture the key characteristics of the individual studies—an essential step to ensure that their context is preserved (Thomas & Harden, 2008). This tool included information on authors, year of publication, study location, recruitment strategy and sample, context (e.g., living conditions and health status of participants; prior experience with mHealth, etc., insofar as this information was available), the sort of technology used, research aims, and major findings. The results are displayed in Appendix B. The description of the selected studies is presented in the Findings section of this paper.



**Figure 2.** Flowchart of the search process to identify studies for analysis and synthesis.

**Table 2.** Quality Assessment and Overview of Eligible Studies.

Number of study	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	X
1. Was there a clear statement of the aims of the research?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N
2. Is a qualitative methodology appropriate?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	CT
3. Was the research design appropriate to address the aims of the research?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
4. Was the recruitment strategy appropriate to the aims of the research?	Y	Y	CT	Y	Y	Y	Y	Y	Y	CT	Y	Y	Y	N	CT	Y	N	CT
5. Were the data collected in a way that addressed the research issue?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	CT
6. Has the relationship between researcher and participants been adequately considered?	N	N	N	N	Y	N	Y	Y	N	N	Y	N	N	N	N	N	N	CT
7. Have ethical issues been taken into consideration?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	CT	CT	CT	Y	Y	Y
8. Was the data analysis sufficiently rigorous?	Y	Y	Y	Y	Y	Y	Y	Y	Y	CT	Y	Y	Y	CT	Y	Y	Y	CT
9. Is there a clear statement of findings?	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N
10. How valuable is the research?	++	~	+	++	++	++	++	++	+	+	++	++	~	~	++	++	++	~

*Note.* Y = Yes; N = No; CT = cannot tell; ++ = very valuable; + = valuable; ~ = moderately valuable

#### Papers meeting eligibility criteria for analysis:

- |  |   |   |
|--|---|---|
| 1. Bentley, Powell, Orrell, & Mountain, 2014       | 6. Cook et al., 2016                        | 13. Parker, Jessel, Richardson, & Reid, 2013    |
| 2. Bond & Worswick, 2015                           | 7. Essén, 2008                              | 14. Pecina et al., 2011                         |
| 3. Boström, Kjellström, & Björklund, 2011          | 8. Fairbrother et al., 2013                 | 15. Pritchard & Brittain, 2015                  |
| 4. Boström, Kjellström, Malmberg, & Björklund 2013 | 9. Grindrod, Li, & Gates, 2014              | 16. Shulver, Killington, Morris, & Crotty, 2017 |
| 5. Chung, Thompson, Joe, Hall, & Demiris, 2017     | 10. Hamblin, 2017                           | 17. Steele, Lo, Secombe, & Wong, 2009           |
|  | 11. Horton, 2008                            | X Mort, Roberts, & Callen, 2013                 |
|  | 12. Melander-Wikman, Fältholm, & Gard, 2008 |   |

## Analysis and Synthesis

The first author performed the data analysis. The 17 selected studies were read multiple times to become familiar with their context, content, and key concepts, and then the information was entered into NVivo11-Pro software for qualitative data analysis. Data from the Findings and Discussion sections of each study were coded inductively, varying from small parts of sentences to larger sections in order not to lose sight of the context of what was being presented in each



paper. Contributions made by participants other than older people, such as caregivers or HCPs, were omitted. The codes were applied across the studies and new codes added where necessary. After each study was coded completely, the individual codes were examined for their internal consistency of interpretation and then combined to form descriptive themes. Codes that essentially addressed the same issue were merged; codes that were related to one another were joined together to form a tree-shaped hierarchy. Through this process, overarching themes started to emerge. An example of this process is presented in Table 3. The final stage of the synthesis uses the research aims as a framework for interpretation of the themes. This means that the inductively developed themes are collated and presented in a way that addresses the research aims. Due to its interpretive nature, this process is difficult to describe (Thomas & Harden, 2008). The identified themes relating to barriers and facilitators of mHealth usage of older people were discussed with the second author and are presented in the Findings section of this paper.

**Table 3.** Example of the Process of Developing the Themes from Coded Texts from the Articles.

<b>Example of Coded Text</b>	<b>→ Code</b>
"In particular, many found it helpful to know their oxygen saturation and to learn their 'normal' range by identifying telemonitoring data trends over time."	Increases knowledge and awareness
"She could've looked at it and said, "Yeah, hey, I need to take this pill" or there's a reminder."	Helps to remember medication
"I might be able to try to become active for my health."	Helps to change behavior
"One proposed benefit of home telemonitoring is earlier detection of a decline in health status that would allow intervention at an earlier stage of illness."	Can prevent deterioration
"Participants noted several potential ways mHealth could help to improve pain care, including assisting patients to reach healthcare providers more expeditiously."	Enables communication with professionals
"The time-saving and convenience of not having to travel to appointments or exercise classes afforded by video consults was a consistent theme."	Can save time
<b>→ Descriptive Theme: <i>Helps to manage health condition</i></b>	
<b>→ Subtheme: <i>Functional Requirements</i></b>	
<b>→ Theme: <i>User Requirements</i></b>	

## FINDINGS

The 17 eligible papers for this study involved a total of 541 participants. Some of the reviewed studies included participants under the age of 60 but were still included in our analysis because the mean age of all participants was well above 60. Four studies included caregivers or HCPs, whose contributions were omitted from analysis. In terms of people's living and health conditions, their care arrangements, ethnic, educational, and socioeconomic circumstances, the studies were generally very diverse, insofar as this type of information was available. Table 4 provides a description of the included studies.

We identified nine themes or subthemes influencing older people's acceptance of mHealth from participants' views and experiences: (a) Perception of Usefulness, (b) User Requirements,

**Table 4.** Description of the Information Provided by the Included Studies.

<b>Included studies</b>		
1. Bentley et al., 2014	7. Essén, 2008	13. Parker et al., 2013
2. Bond & Worswick, 2015	8. Fairbrother et al., 2013	14. Pecina et al., 2011
3. Boström et al., 2011	9. Grindrod et al., 2014	15. Pritchard & Brittain, 2015
4. Boström et al., 2013	10. Hamblin, 2017	16. Shulver et al., 2017
5. Chung et al., 2017	11. Horton, 2008	17. Steele et al., 2009
6. Cook et al., 2016	12. Melander-Wikman et al., 2008	

<b>Feature</b>	<b>Description</b>	<b>No. of study</b>
<b>Participants</b>	Participants under the age of 60 included	1, 2, 6, 8, 9, 15
	Caregivers or HCPs included	2, 8, 10, 15, 16
	Participants with no prior mHealth experience included	5, 9, 17
	Participants who declined mHealth included	1, 2, 6
<b>Terminology used</b>	mHealth	13
	Mobile medication management applications	9
	Telehealth	2, 6
	Telecare	1, 6, 10
	Telemonitoring, home-based monitoring, monitoring technologies	4, 5, 8, 11, 14
	Telerehabilitation	16
	Electronic care surveillance	9
	Mobile safety alarm, alarm pendant, personal emergency response system ("PERS")	3, 12, 15
<b>Technology used</b>	Pendant/wrist alarm	1, 3, 6, 10, 11, 12, 15
	Extended wrist alarm (includes GPS, accelerometer, vital signs monitoring, or fall detector)	4, 7, 12
	Smartphones or Tablet PCs	1, 9, 13, 16
	Intel Health Guide	8, 14
	Vital parameter monitor/sensor	2, 4, 5, 6, 8, 14, 17
	Technology for health/disease management	2, 4, 5, 6, 8, 10, 13, 14, 16, 17
	Wearable falls sensors	11, 12, 17
	Bed/chair occupancy sensors	10, 11
	Motion sensors or accelerometers	4, 5, 16
	Medication reminder systems	9, 10
	Studies using existing technology	1, 2, 3, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16
	Studies using hypothetical technology	4, 5, 13, 17
	<b>Study location</b>	Australia
Canada		9
Sweden		3, 4, 7, 12
UK		1, 2, 6, 8, 10, 11, 15
USA		13, 14
USA & South Korea		5

comprising Functional Requirements, Technical Requirements, and Personalization, (c) Self-efficacy, (d) Sense of Self and Control, (e) Privacy and Confidentiality, and (f) Cost. These themes are explicated in the subsections below.

## Perception of Usefulness

Perceived or experienced need, usefulness, and benefit of a device or service significantly influenced uptake and engagement with technology [Studies 1, 5, 6, 9, 16, 17]. Participants who did not feel the need for mHealth—that is, did not see any advantages over strategies they already employed to help them cope or felt that the services offered did not fit their requirements—were less likely to perceive devices as useful and thus did not use them [Studies 5, 8, 9, 10, 11, 13, 14, 16, 17]. There generally did not appear to be a big difference between older people who had and those who did not have prior experience with mHealth in terms of perceived usefulness. Rather, whether a service or device was seen as useful depended on whether people perceived a need for assistance and whether they thought technology would suitably address that need.

Many older people acknowledged the potential usefulness of services and devices but did not feel they needed them personally because they were happy with the services the health or care systems already performed for them, thought they had sufficient support from their social network, or felt they were not old, sick, or frail enough yet [Studies 1, 4, 5, 6, 9, 11, 17]. This is illustrated in the following statement:

*Wendy had experienced frustration at her father's refusal of the pendant alarm. At the same time she was horrified by the thought of a family member suggesting the pendant alarm to her: "I would be horrified if someone said that to me because it would be their way of saying to me you are losing it you are not managing or coping and nobody wants to have that said to them." (Bentley, Powell, Orrell, & Mountain, 2014, p. 227)<sup>2</sup>*

As is apparent from this account, technology had the potential to influence older people's sense of self, which is discussed in more detail later. User requirements, both functional (what a device can be used for) and technical (how a device operates), as well as the possibility to personalize the functions and design of a device to individual need and preferences, were found to influence perceived usefulness and are discussed below.

## User Requirements

User requirements were found to be an important theme. This theme is divided into the subthemes Functional Requirements (what devices can be used for), Technical Requirements (how devices operate), and Personalization (whether device is adaptable to fit functional and aesthetic preferences).

### Functional Requirements

Participants generally seemed to appreciate devices that allowed them to manage their disease. In this case, people felt the devices could help them increase their knowledge and become more aware of their disease [Studies 2, 5, 6, 8, 9, 14, 16]. They valued technology that could help

them to remember their medication [Studies 6, 9], identify and alter behavior perceived as unhealthy, and motivate them to become more active [Studies 14, 16]. Monitoring their health could help them make better decisions or prompt interventions from HCPs involved in the service, thereby potentially delaying or preventing a deterioration of their conditions [Studies 2, 5, 6, 8, 14].

Feeling that HCPs were watching over them and would offer advice or intervene, if necessary, was viewed as very useful by participants [Studies 6, 7, 13, 14, 16]. Additionally, many older people appreciated that mHealth could save them time and unnecessary trips to the doctor, which were arduous for some of them [Studies 6, 7, 14, 16], either by allowing them to contact HCPs remotely or by managing their health themselves.

*It keeps me from running back and forth to the ER [emergency room] and whenever I start to feel a little queasy, it's about my heart, I take my blood pressure which is so convenient instead of running to the hospital. (Participant identified as Male, age 75, in Pecina et al., 2011, p. 464)*

*Participants appreciated the convenience of not having to travel to appointments for rehabilitation services and recognized the value of telerehabilitation for people living in rural and remote areas, when travel is a significant barrier. (Shulver, Killington, Morris, & Crotty 2017, p. 125)*

For some people, regular contact with call-center operators or HCPs via mHealth could reduce their feelings of loneliness and social isolation [Study 16]. However, many stressed that, no matter how useful a system is, mHealth cannot and must not completely replace face-to-face contact with HCPs [Studies 1, 9, 16, 17].

Many participants expressed the desire to stay in their own homes and to avoid having to go to a care facility [Studies 1, 7, 10, 11, 17]. For this purpose, mHealth was viewed as useful in that it could give them and their relatives the peace of mind of knowing that they are looked after while living alone and would receive help in case of emergencies. These sentiments were expressed in all of the reviewed studies, apart from Studies 2, 8, 9, and 16. Mostly, people were afraid of falling and not being able to get up again or call for help [Studies 5, 11, 12], whereas a few others were concerned about violence in their neighborhoods and appreciated the feeling of security a mobile safety alarm could provide [Study 12]. Using fall detectors or pendant alarms made some older people feel safe enough to take more risks and be more active and mobile, which they experienced as liberating [Studies 3, 10, 11, 12]. One participant referred to the service as insurance: “*You have got to see it in the same light as insurance, because that is what it is really, it's insurance*” (Participant identified as Georgina in Bentley et al., 2014, p. 231).

However, having to rely on the devices and the associated service also could feel like a loss of independence to older people, resulting in them having to weigh the costs and benefits [Studies 4, 6, 10, 15]. This potential impact on a person's sense of self is further explained later in this paper, but characterized here with this quote:

*As you get older and you have to depend on maybe other people or different things, you feel it's part of your independence being taken away, but then when we got it and we realised it freed us up from worry, so that bit of independence had actually been given back to me. (Participant identified as Mrs Swallow, aged in the 60s, in Hamblin, 2017, p. 136)*

## Technical Requirements

Participants wanted an easy-to-use and understandable system [Studies 1, 2, 6, 9, 12, 13, 14, 17] and did not want to have to spend a lot of time using it and learning how to use the technology [Studies 6, 9, 10]. Many older people voiced the desire to know more about how their systems worked, what its functions were, and whether any alternative, possibly more advanced, technology was available; they also felt they did not receive enough information from providers and referring HCPs [Studies 1, 3, 6, 7, 10, 11, 17]. Some participants stated that they did not know how their systems worked or how to use them correctly, which in some cases led to frustration [Studies 7, 9, 10, 11]:

*Many who had never activated their telecare device(s) were unclear about what would happen if they did; they were unsure as to who would answer the call, whether an ambulance would attend and how the responder would access their property. (Hamblin, 2017, p. 137)*

Others did not want to know how the technology operated [Study 7]. Some older people preferred to receive information concerning mHealth face-to-face from their referring HCP rather than being overwhelmed by a deluge of leaflets and information material, as often happened after a stay in hospital [Study 6]. Others wanted an easily understandable manual that needed to take possible language barriers into account [Studies 5, 6, 9, 17]. Being able to get the information needed to operate the technology confidently appeared to impact people's self-efficacy, which is discussed in more detail later. Devices had to be as nondisruptive as possible and easily integrable into people's daily routines or risk being abandoned or forgotten [Studies 4, 6, 9, 10, 11].

*I was good for the first few months, then I went away for a few days, and I couldn't have it with me because it wouldn't work in my daughter's house. Then I came home and I suppose it's like most things, you try it for a while and then you forget it. (Participant identified as Female, age 77, in Horton, 2008, p. 1189)*

Having dependable technology and reliable operators was seen as an essential requirement of any mHealth system, a conclusion drawn from a UK-based study. *"However, as stated by our participants, the most important consideration in a person's decision to use a piece of technology is that the equipment, and the team behind the equipment, are reliable and operate as they should"* (Bentley et al., 2014, p. 232).

Some participants expressed concerns of having to rely on technology for accurately diagnosing illness or an accident [Studies 3, 5, 9, 17], whereas others stated that they trusted that it worked correctly [Study 6]. Faulty technology could lead to the abandonment of the service [Study 6], especially in case of multiple false alarms, which older people experienced as embarrassing or annoying [Studies 1, 10, 11, 15]. Many older people stated that they did not know what to do if the system required maintenance (e.g., a battery-change) or malfunctioned [Studies 6, 16] and expressed the wish for ongoing support [Studies 2, 5, 6, 10, 16, 17]. In Study 17, participants were concerned about potential health impacts resulting from technology use, especially when discussing the possibility of implanting sensors under the skin:

*Some participants were aware of the fact that the sensors communicate with each other wirelessly and had concerns on whether those waves may cause cancer. Questions about*

*whether embedded sensors may cause allergic reactions were also raised. A few participants showed concerns regarding to the pain they may experience if a sensor is required to be planted underneath their skin. (Steele, Lo, Secombe, & Wong, 2009, p. 793)*

The usability of mHealth was limited if it was uncomfortable to wear or constraining (e.g., neck-worn pendant alarms or belt-worn fall detectors; Studies 1, 10, 11). A further restriction was the limited reach of some services that were wirelessly connected to a home base (e.g., pendant alarms). Many participants expressed uncertainty as to how far their system could reach, often resulting in avoiding places in the home that they felt were out of range [Studies 3, 10, 11, 12].

## Personalization

Participants differed on what functionalities could be useful and relevant for them [Study 17]. Many older people expressed the need for technologies and services to take physical, cognitive, and sensory impairment into account [Studies 1, 6, 9, 10, 11, 13, 14, 15, 16, 17], highlighting that there are no one-fits-all solutions. When asked, many participants had ideas how services could be improved in regard to usefulness and usability and often voiced the desire to be included in the design and development processes [Studies 3, 6, 12, 16].

The design of the devices was of great importance. Many participants expressed the view that technology designed for older people was unattractive and often uncomfortable to wear [Studies 1, 10, 15]. Although technology was less problematic in the privacy of their own home [Study 1], older people wanted technology to be inconspicuous and not easily identifiable as a health-care device when they went out in public. The design of devices could impact significantly people's sense of self, which is discussed in more detail later. People had many suggestions and preferences regarding technology design, which ranged from embedding devices in clothing and wearing them on the wrist instead of the neck to making them smaller and resembling jewelry or watches, or even having technology implanted under their skin [Studies 1, 6, 10, 17].

*I want a gold chain. I don't like the rope! Could they not make like a little bracelet? Yes, it's for an emergency. You can't expect it to be beautiful, but when the gold ones come out I want to be first on the list. (Participant identified as Mrs. Tyne, aged in her 90s, in Hamblin, 2017, p. 134)*

Technology associated with youth, such as smartphones and tablet PCs, were generally appreciated, if not necessarily used, and some participants suggested incorporating functions of traditional telecare services into those devices [Studies 1, 16]. In some cases, people tinkered with and adapted the devices they were given; in other situations, they refused the offered services and looked for alternatives that were cheaper and better suited their requirements [Studies 1, 3, 9, 16].

## Self-Efficacy

Older people's faith in their own ability to operate devices successfully had a great impact on their adoption of mHealth. Some participants felt competent [Studies 2, 3, 9, 16], whereas others questioned their ability to use the technology correctly, and some even expressed dislike or a fear of it [Studies 4, 6, 10, 17]. *"There were discussions of apprehension and dislike*

*towards technology across the 'non-users' who felt they lacked the confidence and experience to use technology"* (Cook et al., 2016, p. 13).

Participants were often afraid of damaging the devices, making mistakes, or triggering accidental alarms [Studies 1, 9, 10, 15]. Previous experience with technology, for instance, computers, video recorders, or various information and communication technologies (ICTs), greatly influenced the participants' self-efficacy. Avid users of technology usually expressed faith in their abilities, whereas participants who previously experienced difficulties with other devices tended to be more apprehensive [Studies 1, 2, 3, 9, 12, 16, 17]. Friends' or relatives' experiences with mHealth also could affect older people's expectations of their own abilities to use technology effectively. In examining Korean and Korean-American participants' views, researchers in Study 5 found that culture too can influence. Older Korean people appeared to be more open to the idea of using mHealth as compared to their Korean-American counterparts, which was explained by the fact that Korea is considered a very tech-savvy nation.

Participants often voiced the desire to receive training and some were eager to learn, especially when mHealth was used for managing disease and because the technology used was associated with youth [Studies 13, 16, 17]. Researchers in Studies 9 and 16 found that participants became more comfortable and confident the longer they actively used their devices. People had varying views regarding the amount of information they required or desired about how their device worked or the connected service operated. It appeared that older people who had faith in their abilities and were more proactive in using technology wanted to know more about it whereas those who were more apprehensive did not.

### **Sense of Self and Control**

Being able to maintain their identity and their sense of self was very important to participants. MHealth, especially if used for care purposes, posed a threat to people's self-concept in that it made them feel older, frailer, more vulnerable, and more dependent on others than they liked to see themselves [Studies 1, 6, 12, 15]. More importantly, it could change the way they were perceived and treated by others [Studies 1, 6, 10, 15]. Using mHealth was particularly problematic if the technology's design was felt to be stigmatizing, signposting a person's frailty and inability to manage on his/her own. This evoked a sense of shame [Studies 1, 6, 10, 15, 17]. Some people were afraid of social prejudice and discrimination: *"Well, I think she feels that it, sort of, draws attention to her frailty which she doesn't really want to do because she's always been very strong and now she isn't as strong"* (Pritchard & Brittain, 2015, p. 129).

Some people who used mHealth to manage their state of health felt that the technology led to an unwanted constant awareness of their ill health [Studies 6, 9, 14]. For others, however, perceiving themselves as vulnerable, frail, and in need of help had the effect that they found mHealth and the remote monitoring of their well-being more useful and acceptable [Studies 1, 6, 17]. Some older people managed to reframe their technology (e.g., pendant alarm) as a "lucky charm," which helped them to overcome feelings of stigmatization [Study 10]. A very few highlighted that these technologies also were used by younger people living with disabilities. This removed the age-related, but not the vulnerability-related, stigma [Study 1].

Participants worried that using mHealth could lead to them being viewed as a "something" rather than as a someone by service providers [Studies 4, 15]. As demonstrated by this quote from a participant in Study 4, *"You become a stranger ... you become nothing ... and, I mean,*

*how can they care about you when they do not know who you are.*" (Boström, Kjellström, & Björklund, 2013, p. 122).

However, technology connected to call-center operators or directly to HCPs who participants knew and trusted was viewed very positively [Studies 7, 16]. As indicated by Essén (2008, p. 134), "*Being surveilled by the care personnel who they trust makes the seniors feel safe.*"

Many older people stressed that they did not want to be perceived as a burden. This often resulted in them avoiding "risky" activities, such as not trying to get up on their own if they had fallen previously or not activating their devices even if they really did need help [Studies 1, 6, 10, 11, 12].

*Participants frequently used the language of not wanting to "bother people" as the rationale for not using their devices in an emergency. (Hamblin, 2017, p. 135)*

*One informant with functional limitations thought that a mobile alarm could be used to "test the limits," but that in his case a mobile alarm would not make him move around more because he did not want to place the responsibility on those answering the alarm. (Melander-Wikman, Fältholm, & Gard, 2008, p. 342)*

Many participants stated that they only agreed to use mHealth to appease relatives or HCPs, and some even felt they had been pressured to use the services. For some in this latter group, such perceptions had the effect that they wore their devices only when they expected a visit from their relatives or HCP [Studies 6, 7, 10, 15]. Having control over how, when, and whether at all they used their devices was very important to older people and served as a way of asserting their independence—or to rebel against those who had decided on use for them [Studies 1, 15]. Thus, many participants wanted devices that could be switched off, or they simply decided not to always wear or use them [Studies 9, 17]. Devices that automatically and constantly monitored aspects of their lives were thus seen as particularly problematic [Studies 6, 10, 15]. Participants stated that they were competent of deciding for themselves if they needed and wanted mHealth and wanted their choice to be respected [Studies 1, 13, 17]. Furthermore, people wanted to decide for themselves if they needed help in a given situation and to be in control of when devices sent an alarm [Study 10]. These were essential technical requirements for many older adults.

## **Privacy and Confidentiality**

Most participants did not express concerns in regard to data confidentiality [Studies 4, 10, 16, 17]. They did not perceive their personal or medical data as interesting enough for third parties and thought that the modern surveillance society had already collected everything there was to know about them [Studies 5, 12, 17].

*I do not care in the least! There are so many security-policethings [sic] today and they are for my benefit. I mean "Big Brother" is already watching you all over. (Participant identified as P1, in Melander-Wikman et al., 2008, p. 342)*

*Participants do not perceive their medical data, such as heartbeat, pulse or blood pressure to hold any significant value to an outsider, with one participant dismissing the "Privacy" issue with the following comment: "What's in it that's private?" (Steele et al., 2009, p. 796)*



Mostly they trusted providers and HCPs involved in the service to protect their data and were generally not aware of the potential risks and consequences of a confidentiality breach [Studies 10, 12, 16, 17]. However, heightened awareness of insufficient data protection could negatively impact users' acceptance of mHealth [Study 17]. Participants' statements in the study conducted by Grindrod, Li, and Gates (2014; Study 9) suggest that their trust depends on who operates the system. As an example, Grindrod et al. noted that older people were suspicious of technology operated by an insurance company, fearing that the collected information could be used against their insurance claims.

In terms of digital surveillance and personal privacy, the views of participants were more ambiguous. Although some stated that they had nothing to hide and preferred digital over face-to-face observation [Studies 7, 12, 13, 16, 17], others expressed their discomfort with continuous monitoring of their behavior and movements and the possibility of being judged [Studies 4, 5, 7, 11, 13, 17].

*It hits me, when I lay down late in the mornings that this is monitored. Also, at times when I can't sleep and get up in the middle of the night I sometimes think that this might be seen.”* (Participant identified as Siv, in Essén, 2008, p. 133)

*The possibility that someone may look at the data collected about her, and the possibility that her data may not look “normal” bothered this woman.* (Essén, 2008, p. 134)

For some participants in Study 4, by Boström et al. (2013), the idea of being surveilled or monitored reawakened negative memories of being spied on in East Germany during the Cold War. It should be noted that restrictions of privacy were generally accepted by the study participants if they were perceived as necessary for the service provided (e.g., position tracking for mobile safety alarms) for which older people saw a personal need or benefit [Study 4, 12, 16]. This connects this theme to the theme Perception of Usefulness. On the other hand, functions considered unnecessary or overly intrusive, such as cameras or voice recordings, were seen as potential violations of privacy and often rejected by the older persons [Studies 4, 5, 12, 17].

## Cost

The cost for equipment and associated services was a concern to many participants and was described as a major barrier to mHealth adoption [Studies 5, 13, 17]. Many participants pointed out that older people usually have to make do with a very limited income and thus have to prioritize their spending. MHealth, even if perceived as useful, was generally considered nonessential and for which money could be spent only if enough funds were left after taking care of the bare necessities [Studies 1, 13, 17]. As Bentley et al. (2014, p. 223) stated, *“Some people who could benefit from Telecare may simply not be able to afford it without foregoing essentials such as food and heating”*.

Some older people were not aware of the precise cost of the service they were using or intended to use due to misinformation by advising HCPs or complicated pricing structures [Studies 1, 10]. High prices for equipment and service sometimes resulted in participants looking for cheaper alternatives, such as buying an alarm button connected to family members or neighbors [Studies 1, 3, 9]. Some participants stated that they would only use the service if their families or the government paid for it [Studies 17]. In the study by Chung, Thompson, Joe, Hall, and Demiris, (2017; Study 5), their Korean participants expressed the

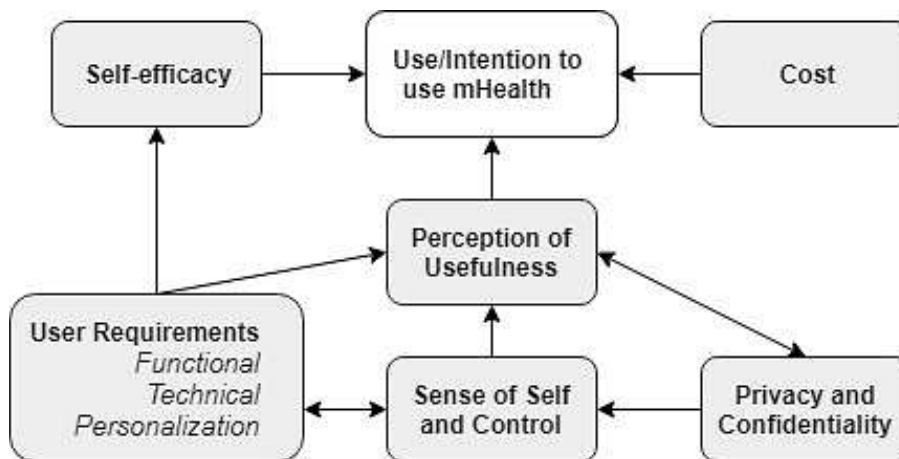
view that the government should improve accessibility and affordability of systems and services and provide subsidies for socioeconomically disadvantaged people. Furthermore, they stated that a competitive market could contribute to price reductions.

## DISCUSSION

The purpose of this study was to understand factors that either facilitate or hinder older people's usage of mHealth. Figure 3 displays the findings and their interrelation, which will now be discussed in more detail.

Perception of Usefulness has been highlighted consistently as a major factor influencing technology acceptance and usage and has been validated several times in a range of quantitative studies in the health-care context (see Holden & Karsh, 2010). In the technology acceptance model (TAM; Davis, 1989; Davis, Bagozzi, & Warshaw, 1989), perception of usefulness is one of the two factors directly influencing both the intention to use and actual use of technology. Essentially, perception of usefulness means that the user must see a personal gain or benefit from using technology. The UTAUT, the unified theory of acceptance and use of technology, refers to this concept as performance expectancy (Venkatesh, Morris, Davis, & Davis, 2003). The TPB, the theory of planned behavior, uses the concept "attitude toward the behavior" to describe a person's belief that a certain act or behavior, such as using mHealth, will have a positive impact on his/her life (Ajzen, 1991).

This qualitative study confirms these findings. Even though there was a general acknowledgement that technology could be useful or serve a purpose, respondents needed to see a personal benefit or the need that a certain device would address in order to perceive it as useful for themselves. Accordingly, the functions offered by a specific device influenced how useful it was to a person through addressing his/her perceived needs. Figure 3 illustrates this interrelation by linking Perceived Usefulness to User Requirements and its subtheme Functional Requirements.



**Figure 3.** Interrelation of the identified themes: (a single-headed arrow represents a one-way relation; a double-headed arrow represents a bidirectional relation between the themes).

Many older adults found technology a useful addition to existing services, although they stated that it could not and should never completely replace personal interactions with HCPs. As the capabilities of mobile devices progress and they become ever more popular, the possibility exists that they could slowly replace traditional face-to-face services, as is increasingly the case with banking, for example. These changes to individual experiences of health care could have incremental societal consequences for patterns of service provision. The rapid development of smartphone apps for all kinds of health- and wellness-related purposes can be seen as a shift from HCPs actively managing health care for people to people managing it on their own (Lupton, 2013; Varshney, 2014).

For technology to be truly useful, it has to be reliable, unobtrusive, and easily integrable into people's lives, which is summed up under the subtheme Technical Requirements. The limited technological capabilities that devices offer to older people (in most cases a pendant or wrist-worn alarm) could lead to unwanted consequences. For example, having to rely on mHealth for safety when living alone could create a "prison of safety" inside the older person's home if the device was connected to a home-base with limited range. While being kept from harm, seniors were consequently restricted in their movements and prevented from active participation in society. Considering that technological capabilities are already available to provide these services free of spatial restrictions in the form of a mobile safety alarm, for instance, the question arises why these still are not offered to older people on a routine basis. Furthermore, older people wanted devices that were easy to handle and understand. This finding is mirrored in TAM's perceived ease of use, UTAUT's effort expectancy, and TPB's perceived behavioral control variables, which state that the perception of the physical and mental effort required to use technology influences the perception of usefulness and consequently the use of technology (Ajzen, 1991; Davis, 1989; Davis et al., 1989; Venkatesh et al., 2003).

Older people are a diverse group with different needs, capabilities, and preferences; the people included in this study wanted the option to personalize the needed functions and the design of the device to their personal requirements and tastes. People can generally be very inventive and creative in devising ways to counterbalance any experienced limitations or deficits (Loe, 2010; López Gómez, 2015). In fact, some participants in this study tinkered with the mHealth devices provided to them to make them more suitable for their individual requirements.

The design of mHealth is very important to people as it has the potential to impact on their sense of self. Public discourse promotes the ideal of active, autonomous, and independent seniors (López Gómez, 2015; Mort et al., 2013). The design of gadgets, however, often is perceived as stigmatizing, especially for devices specifically developed for older people. Thus the opposite—namely a frailer, more vulnerable, and less capable identity—is superimposed on seniors. López Gómez (2015) pointed out that people give objects and actions significance that is not necessarily visible or comprehensible to others. Technology too can be attached to a certain meaning (Lupton, 2013). This should be acknowledged by developers and providers and anticipated as much as possible. Many older people whose views were included in this study experienced friction between their sense of self and how they were viewed by others or made to view themselves because of mHealth. This frequently led to feelings of embarrassment and/or rebellion against the technology, leading to nonuse.

Although the general intention of geriatric technology development is to make older people more independent through mHealth, some of the participants of the reviewed studies felt

themselves become more limited and dependent on the devices and services provided. Some people, it seemed, internally struggled to come to terms with their loss of independence and increased need for assistance. This impacted on their perception of usefulness of mHealth and was often in stark contrast to the views of their relatives or HCPs. It was frequently the case that older people felt that they had been persuaded or even coerced by relatives or HCPs to accept technology. Forcing older people to adopt technologies for which they see no use, which they find difficult to integrate into their daily lives, and which can have a negative impact on their sense of self is both ethically highly questionable and a barrier to the realization of technologists', HCPs', and relatives' aspirations for implementation. Having control of how, when, and whether at all the devices were used was thus an important way for older people to assert themselves and maintain their sense of self. The relationship among the two concepts Sense of Self and Control and User Requirements is bidirectional, symbolized by a two-headed arrow in Figure 3. Being able to assert control over the device was a fundamental requirement. Poorly designed mHealth could negatively impact older people's sense of self. On the other hand, devices that fitted well with people's needs and preferences in both function and design, and allowed them a maximum of control, could help the users maintain their image of themselves.

Privacy and Confidentiality were found to play an ambivalent role. Privacy appeared to be a concern, whereas confidentiality seemed to be an issue most older adults did not consider unless it was brought up by researchers. Many older people seemed to be unconcerned or unaware of issues surrounding confidentiality, stating that they trusted their HCPs to keep their data safe or that they did not think it held any particular value. French and Smith (2013), however, highlighted how the respondents' information potentially could be used to their disadvantage, for example, by ratifying discriminating policies based on conclusions drawn from decontextualized personal data. In regard to privacy, a thin line appears between technologies collecting enough information about older people to serve their purpose, that is, to keep them safe and healthy, and becoming intrusive. Feeling watched had, for some, the effect that they became self-conscious and felt judged, which impacted their sense of self. Certain functions, such as video recording, were widely rejected as too invasive, whereas for other functions it seemed that people had to weigh the pros of being able to address their needs against the cons of having to sacrifice their privacy. This ambivalent relationship between Perceived Usefulness and Privacy is symbolized by a double-headed arrow in Figure 3.

Self-efficacy was another factor that directly influenced the usage or intention to use mHealth. Many older adults lacked faith in their abilities to successfully operate the devices and some even expressed a fear of them. It was shown that a device that is easily understandable and operable could increase people's faith in their own abilities to use it effectively, which links this concept to the User Requirements subtheme Technical Requirements. Furthermore, many older adults voiced the wish to receive training and ongoing support and it appeared that people's trust in their capabilities increased the longer they used mHealth. The TPB presented a person's expectation of succeeding at a task as an important factor that influences decisions and behavior (Ajzen, 1991). Sufficient knowledge and support are seen as facilitating conditions under the UTAUT (Venkatesh et al., 2003). People's experiences with technology throughout their lives, but also other people's accounts of using mHealth, could influence the older users' self-efficacy in both a positive and a negative way. Both the UTAUT and TPB characterize social and cultural influence as important factors impacting the intention to use and actual usage (Ajzen, 1991; Venkatesh et al., 2003). This suggests that, as technology increasingly becomes a natural part of

people's lives, it might be expected that using technology for health and care purposes will gradually become more normal for future generations.

The final factor that had a direct impact on whether older people used or intended to use mHealth was the cost of the device and service. Despite perceiving a personal need and benefit from mHealth, people decided not to use it if they felt that they could not afford it. Confusing or nontransparent pricing schemes for services and technology posed an additional barrier.

This discussion makes clear that any form of mHealth is a complex intervention, set in the biopsychosocial context of an individual older person's life and involving a multitude of stakeholders who might have different motivations and interests (Barlow, Bayer, & Curry, 2006). Although the capabilities of individual devices are steadily advancing, conclusive evidence cannot be drawn concerning their effectiveness and cost-efficiency (Barlow et al., 2007; Turner & McGee-Lennon, 2013). Therefore, it is unhelpful to position and push technology, mobile or otherwise, as a quick fix or a panacea for societies' and the health-care systems' problems perceived as related to population aging. Furthermore, as Mort, Roberts, Pols, Comenech, & Moser. (2015) stated, technology can never be a solution in itself but rather implies a shift in responsibility, a reorganization of existing support structures, and the creation of additional tasks that, in the case of most older people, generally fall on the shoulders of relatives, neighbors, and friends. Hence, an important consideration should be who profits most from equipping older people with mHealth.

Additionally, it should be noted that using the term older people without considering the diversity of this demographic group is just as problematic as assuming that technology is the easy solution for limited health care resources. Often, the very heterogeneous population group referred to as older people is reduced to a single common characteristic: age. Thus, the risk of oversimplifying and generalizing older people's circumstances and experiences is high. One such generalized assumption is that older people need care and looking after. This begs the question of what these care needs are, who defines them, and who evaluates whether a person's needs have been met.

## CONCLUSIONS

In this paper, we used thematic synthesis to gain a thorough understanding of the barriers to and facilitators of older people's usage of mHealth. If mHealth is to fulfill some of its stated potential of reducing health- and social care expenditures while simultaneously increasing older people's autonomy and quality of life, mHealth researchers and designers must acknowledge and learn from older users' experiences, views, and concerns. Due to the complex nature of mHealth interventions and the heterogeneity of the demographic group of older people, a one-fits-all mHealth solution cannot possibly exist. Many factors influence older people's perceptions of the usefulness and usability of mobile technologies and thus the likelihood of their uptake. However, it should be questioned why technologies are being presented as a panacea to problems of society and health-care systems associated with an aging population if their effectiveness and cost-efficiency are still not established. As mHealth devices cannot provide care by themselves, they can only be viewed as a tool to reorganize and redefine existing health and social care structures (Mort et al., 2015). Technological progress may create

opportunities for development and change for the better. However, questions should be asked regarding who profits most from mHealth provided to older people and how to ensure that the older users feel supported rather than coerced by it.

A key strength of this study is that it includes the views of older people who currently use mHealth, had previously used and decided to abandon it, had declined the invitation to use it, and had never used nor heard of mHealth before. Additionally, it includes one study directly investigating cultural influences on older people's views. Insofar as this information was available, participants had diverse sociocultural and economic backgrounds, living arrangements, and health conditions.

This study has several limitations. MHealth as of yet lacks a clear definition, with some researchers only referring to smartphone apps and others including all kinds of mobile ICTs and sensors used for health-care delivery. This study thus has used its own definition of mHealth, which may not concur with other researchers' or developers' understandings. Despite smartphones and tablet PCs increasingly taking over functions from more traditional telecare and telehealth services and many apps being created for health and care purposes, very few studies directly address older people's views of these devices. Although most studies included in this paper explicitly used mobile technologies, some also included devices that were not meant to be carried around (e.g., motion sensors, bed-occupancy sensors) or not strictly used for health or care purposes (e.g., smoke detectors). Additionally, six studies included participants under the age of 60 and it was not always possible to identify and omit younger participants' contributions. A further limitation is that the literature search was limited to a systematic search of the defined databases and a manual checking of the reference lists of selected articles. It would have been desirable to include a technological database alongside the ones ultimately used, although the number of qualitative articles published in journals cataloged by such a database might be limited. Therefore it cannot be guaranteed that all relevant articles were identified, although this is not necessarily required, as discussed by Thomas and Harden (2008).

As mHealth gathers pace internationally, technology providers, policy makers, and HCPs urgently need to better understand older people's views and experiences with a range of technologies used for health and care. Without that, evidence on the efficiency and cost-effectiveness of mHealth will remain incomplete.

## **IMPLICATIONS FOR APPLICATION AND POLICY**

Even though this research makes clear that there can be no one-fits-all mHealth device or service, the findings presented in this paper contribute to the knowledge regarding health and care technology as well as some guidance for technology developers and providers of mHealth initiatives for older people. To begin with, it is essential to meaningfully include the target population in the technology development process. Apart from knowing their own circumstances and needs best, older people have many ideas regarding what technology should do for them. In terms of design and functionality, seniors want dependable devices and services on which they can fully rely, and which do not brand them as vulnerable and incompetent. They want to be able to personalize devices to their individual requirements and, ideally, aesthetic preference. It is crucial that devices do not limit older people in their mobility and their activities. Furthermore,

devices must be affordable, as unobtrusive as possible, and easy to understand and operate. There should be clear information concerning pricing schemes and data protection policies. Disruptions in people's privacy must be kept to a bare minimum and be allowed only if it is required for the service provided. People must be informed about the precise nature of these intrusions and given the opportunity to decline. Ongoing technical and emotional support from mHealth providers, as well as initial training, also are valued. Furthermore, it is important that services remain personal and respectful, ensuring that older people are viewed as individuals and not impersonalized as simply an alarm or health condition to be monitored. Providers should acknowledge that nonuse of mHealth or older people using it differently than intended by providers is a result of people not wanting or needing it or having been provided with technologies that do not suit their specific requirements or lifestyles. As a consequence, the devices are therefore adapted to fit better into older people's lives or "abandoned."

## ENDNOTES

1. Information on the history of the iPhone is detailed on [http://en.wikipedia.org/wiki/History\\_of\\_iPhone](http://en.wikipedia.org/wiki/History_of_iPhone)
2. The data quotes provided in this paper are drawn from previously published papers. Therefore, any errors in regard to grammar, spelling, or punctuation are exactly as they appeared in the original publications.

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## Appendix A: Search Strategy

Presented below are a series of tables that displays the search strategies used for the individual databases. The tables are a print-out from the databases, which is why they differ slightly in their presentation (i.e., CINAHL is listed in reverse chronological order and displays an S in front of every search step and ASSIA presents the search string in one ongoing line). MEDLINE was chosen for its focus on biomedical literature. CINAHL is a database for literature on nursing and allied disciplines. ASSIA indexes sociological literature and PsycINFO lists content from psychology.

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### CINAHL → Results: 136 studies

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- S25. S20 AND S23 Limiters- Publication Year: 2007-; Peer Reviewed; English Language; Age Groups: Aged, 65+ years [Find all my search terms]
- S24. S20 AND S23 [Find all my search terms]
- S23. S21 OR S22 [Find all my search terms]
- S22. (MM "Semi-Structured Interview") OR (MM "Unstructured Interview") OR (MM "Narratives") OR (MH "Observational Methods+") OR (MM "Focus Groups") [Find all my search terms]
- S21. (MH "Qualitative Studies+") [Find all my search terms]
- S20. S15 AND S19 [Find all my search terms]
- S19. S16 OR S18 [Find all my search terms]
- S18. "senior\* OR senior citizen\* OR elderly OR old OR older people OR pensioner\*" [SmartText Searching]
- S17. "senior\* OR senior citizen\* OR elderly OR old OR older people OR pensioner\*" [Find all my search terms]
- S16. (MH "Aged+") [Find all my search terms]
- S15. S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 [Find all my search terms]
- S14. (MH "Wearable Sensors+") [Find all my search terms]
- S13. "technogenerian" [Find all my search terms]
- S12. "gerontechnolog\*" [Find all my search terms]
- S11. "telemonitor\*" [Find all my search terms]
- S10. "remote care technolog\*" [SmartText Searching]
- S9. "remote care technolog\*" [Find all my search terms]
- S8. "digital health" [Find all my search terms]
- S7. (MM "Home Health Care Information Systems") OR "HIT OR health information technology" [Find all my search terms]
- S6. "ICT OR information communication technology" [SmartText Searching]
- S5. "ICT OR information communication technology" [Find all my search terms]
- S4. (MH "Smartphone+") OR (MH "Cellular Phone+") OR (MM "Mobile Applications") OR (MH "Computers, Hand-Held+") [Find all my search terms]
- S3. "mHealth OR mobile health" [Find all my search terms]
- S2. "telecare" [Find all my search terms]
- S1. (MH "Telehealth+") OR (MH "Telemedicine+")
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**MEDLINE → Results: 252 studies**

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1. \*telemedicine/ or \*telerehabilitation/
  2. (mHealth or mobile health).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word,
  3. telecare.mp.
  4. exp cell phones/ or smartphone/ or \*wireless technology/
  5. exp Computers, Handheld/
  6. exp Mobile Applications/
  7. (ICT or information communication technology).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease
  8. (hit or health information technology).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary
  9. digital health.mp.
  10. remote care technology.mp.
  11. telemonitoring.mp.
  12. gerontechnology.mp.
  13. wearables.mp.
  14. wearable sensor.mp.
  15. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14
  16. exp Aged/
  17. (senior\* or senior citizen\* or elderly or old or older people or pensioner\*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept
  18. 16 or 17
  19. 15 and 18
  20. exp grounded theory/ or exp qualitative research/
  21. exp focus groups/ or exp interviews as topic/ or exp narration/
  22. Nursing Methodology Research/
  23. Observation/
  24. ethnography.mp.
  25. 20 or 21 or 22 or 23
  26. 19 and 25
  27. limit 26 to (English language and yr="2007 -Current" and "all aged (65 and over)")
-

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**PsycINFO → Results: 95 studies**


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1. telehealth.mp. or exp Telemedicine/
  2. telecare.mp.
  3. (mHealth or mobile health).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures]
  4. exp mobile devices/ or exp cellular phones/
  5. (mobile applications or apps or smartphone).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures]
  6. (ICT or information communication technology).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures]
  7. (hit or health information technology).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures]
  8. digital health.mp.
  9. remote care technology.mp.
  10. telemonitoring.mp.
  11. gerontechnology.mp.
  12. (wearable sensor or wearables).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures]
  13. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12
  14. ageing/ or exp ageing in place/
  15. (senior\* or senior citizen\* or elderly or old or older people or pensioner\* or aged).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures]
  16. 14 or 15
  17. 13 and 16
  18. limit 17 to (peer reviewed journal and English language and "qualitative (best balance of sensitivity and specificity)" and "380 aged " and yr="2007 -Current")
- 

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**ASSIA → Results: 87 studies**


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((((mhealth OR "mobile health" OR telehealth OR telecare OR SU.EXACT("Telemedicine") OR telemonitoring OR (smartphone app\*) OR (wearable technology) OR gerontechnology OR "information communication technology" OR "health information technology" OR "digital health") AND (SU.EXACT("Elderly people") OR SU.EXACT("Older people")))) AND (qualitative OR (focus group) OR interview OR observation OR ethnography OR (grounded theory))) NOT (subt.exact("carers" OR "hospitals" OR "questionnaires" OR "internet" OR "computers" OR "mortality" OR "relatives" OR "middle aged women" OR "robotics" OR "caregivers" OR "health professionals" OR "mental health" OR "databases" OR "nurses" OR "confidence intervals" OR "councils" OR "electronic mail systems" OR "literature reviews") AND la.exact("ENG") AND pd(20070101-20171231))

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## Appendix B: Data Extraction Form and Description of the Included Studies.

This table displays the main characteristics of the included studies. Presented are the study location, aims/research questions, methods of data collection, sampling strategy, number and (mean) age of participants, technology used, and main findings. Additionally, some information is provided, where available, on the context of the study. This includes whether participants are/have been active users of mHealth or refused it when offered, whether studies focused on the management of specific health conditions or care needs, and whether people lived alone in their own home or had made other arrangements. This ensures that the context of the included studies is preserved. Abbreviations: TC stands for telecare, TH for telehealth and TM for telemonitoring. COPD stands for chronic obstructive pulmonary disease; WNS stands for Wireless Network Systems.

Study	Site	Study Aims / RQs	Data Collection	Sampling	Participants	Technology	Context	Findings (themes/concepts)
<b>1. Bentley et al., 2014</b>	UK	1) Why people choose not to adopt TC when it may be an appropriate intervention in their circumstances? 2) Peoples' perceptions of how best to communicate the benefits of TC to (potential) users.	Semistructured interviews	Convenience sample; self-enrolled via media & community meetings	22 (1<50 yrs., 2 unknown; mean age: 68.4 yrs., range: 40-84 yrs.)	[No precise statement; mostly mention of pendant alarms, environmental sensors, tablets, & smartphones also mentioned]	People refusing TC; wide variation in personal circumstances & health status	1) Stigma 2) Design 3) Awareness 4) Alternative Options 5) Cost
<b>2. Bond &amp; Worswick, 2015</b>	UK	Qualitative findings of an evaluation of a local TH program for patients with COPD or chronic heart failure.	Questionnaire & semistructured phone interviews. (at the start of intervention & after 3 mos.) & 1 focus group with professionals	Purposive sample of interested participants of TH program	29 for initial interview (4≤ 60 yrs.), 24 of those completed follow-up; & professionals	Monitoring equipment for blood pressure, weight, temperature, & oxygen saturation levels, a tablet-style computer that recorded readings from the monitoring equipment	Patients with COPD or chronic heart failure who use TH service; users & nonusers (refused or no longer used service) included	[Merely descriptive findings; no themes or concepts available.]
<b>3. Boström et al., 2011</b>	SWE	Analyze opinions & feelings about mobile alarms (called PERS) from people living in senior housing; highlight their wishes regarding its further development & innovation	5 focus groups	[n/a]	45 (67-97 yrs.)	Wrist or pendant alarm (PERS)	Living alone in senior housing; in good health; use or had previously used PERS; rural/ urban	1) safe & free 2) anxious, afraid & insecure 3) satisfied 4) uninformed 5) active innovators

<b>4. Boström et al., 2013</b>	SWE	How older persons, living at home independently & stating good health, perceive monitoring technology in terms of personal privacy	5 focus groups using open, semistructured questions	Snowball sampling	45 (67-97 yrs.)	Hypothetical wrist-worn device to detect position, vital functions (e.g., temperature, heart rate), & movement	Living alone in senior housing; in good health; experience with mHealth; rural/urban	<ol style="list-style-type: none"> <li>1) maintaining a sense of self</li> <li>2) independence vs. security</li> <li>3) privacy vs. intrusion</li> <li>4) in the best interest of me vs. in the best interest of others</li> </ol>
<b>S5. Chung et al., 2017</b>	USA/ KOR	What factors could increase technology acceptance & diffusion in Korean & Korean-American older adults?	Focus groups & individual interviews	Convenience & snowball sampling; use of gatekeepers to identify & access participants	11 Korean-American, 10 Korean; >65 yrs.	Home-based sensor technologies (participants were given the example of activity & vital sign monitoring, fitness, etc.)	Older Korean immigrants in the US & older adults living in Korea; community dwelling	<ol style="list-style-type: none"> <li>1) general perceptions</li> <li>2) cultural factors impacting tech acceptance</li> <li>3) factors influencing perceived need of tech</li> </ol>
<b>6. Cook et al., 2016</b>	UK	Explore underlying factors that impact on patients' decisions to initially adopt & continually engage in TH & TC applications.	In-depth semistructured interviews	Purposive sample from all patients referred to TH/TC service in the area	28 users (35-92 yrs., median: 67 yrs.) & 9 nonusers (24-92 yrs., median 63.3 yrs.)	TH & TC either connected or stand-alone; a variety of technologies, most of which were mobile	Users & nonusers (declined or withdrawn) referred to TH & TC service; all types of conditions for which TC & TH can be used	<ol style="list-style-type: none"> <li>1) decision to use service at point of referral <ol style="list-style-type: none"> <li>a) acceptance of old age/health condition</li> <li>b) previous knowledge &amp; awareness of the service &amp; equipment available</li> <li>c) perceived usefulness</li> <li>d) attitudes &amp; perceptions towards technology</li> </ol> </li> <li>2) engagement &amp; use of service <ol style="list-style-type: none"> <li>a) usability</li> <li>b) usefulness of equipment</li> <li>c) functionality of equipment</li> <li>d) threat to identity &amp; independence</li> </ol> </li> </ol>
<b>7. Essén, 2008</b>	SWE	Understand not only if but also why seniors feel that electronic care surveillance (TM) does or does not violate their privacy.	In-depth interviews;	Purposive sample	17 (68-96 yrs.)	TM, wrist-worn (collects activity data continuously)	Seniors living alone in their own home; vulnerable & exposed to health risks; used the device for 6-7 mos.	<ol style="list-style-type: none"> <li>1) Care surveillance as enabling the feeling of being cared for</li> <li>2) Care surveillance as constraining – feeling as if under suspicion</li> </ol>

<b>8. Fairbrother et al., 2013</b>	UK	Explore the views of patients & HCPs who were using TM as part of the TELESCOT COPD trial of the impact of telemonitoring on self-management in COPD	Semistructured interviews embedded in TELESCOT trail	Purposive sample from TELESCOT trail	38 patients (44-84 yrs., 1 participant <50 yrs.); mean: 67.5 yrs.) & 32 professionals	[N/a from study report; Web site reveals use of intel health guide, which is a small portable device with a touchscreen to which various health monitoring devices can be connected as needed]	Patients with COPD use the system for 6 mos.; maximum variation in age, SES, disease severity & adherence to the system	Central themes from patients' perspective: 1) knowledge & empowerment 2) accessibility & reassurance
<b>9. Grindrod et al., 2014</b>	CAN	Explore the usability & usefulness of existing medication management applications for adults over the age of 50.	Mixed-method; user testing followed by questionnaire & focus groups	Purposive sample followed by iterative, theoretical sampling	35 (52-78 yrs., mean: 67 yrs.)	Medication management app on tablet or smartphone	Participants take regular medication; no prior experience with touchscreen devices needed; very diverse sample	1) targeted design 2) functionality 3) simplicity 4) accessibility
<b>10. Hamblin, 2017</b>	UK	1) Whether obtrusiveness framework is applicable empirically to the English context? 2) What is the impact of the dimensions of obtrusiveness on the acceptance & use of TC?	Ethnographic observations & interviews supplemented by creative methods (e.g., photos & diaries); longitudinal (4-6 visits in 6-9 mos.)	[TC users of 2 providers approached; no information concerning how they were selected]	60 >65 yrs., caregivers present during interviews (no information on number)	Pendant alarm or TC package (includes GPS devices; bed, door, chair exit & environmental sensors; medication reminder & dispenser systems)	Cognitive impairment and/or proneness to falls; new or established TC users; community dwelling;	1) physical dimension 2) usability 3) privacy 4) functionality 5) human interaction 6) self-concept 7) routine 8) sustainability 9) control 10) information & ongoing support
<b>11. Horton, 2008</b>	UK	Older people's experiences with & expectations of the use of telemonitoring devices such as fall detectors & bed occupancy sensors	In-depth semistructured interviews; part of a larger, observational study	Convenience sample from TC call center database	35 (17 control/18 intervention group); >65 yrs., mean: 78.2 yrs.	Body-worn devices for fall detection & bed-occupancy sensor; control group used only pendant alarm	Experienced falls; without cognitive impairment; living alone or with a part-time caregiver in the community or sheltered housing; registered TC	1) expectations 2) feelings of security 3) call center support 4) barriers to using assistive devices 5) adherence 6) likelihood of using telemonitoring devices



<b>12. Melander-Wikman et al., 2008</b>	SWE	Describe elderly persons' experiences of testing a mobile safety alarm & their reasoning about safety, privacy, & mobility.	Narrative/reflective individual interviews	Purposive sample from a reference group	9 (60-84 yrs.)	Mobile safety alarm [includes GPS & drop sensor & button; allows communication with call center]	With & without functional limits (pain, dizziness, chronic illness, stroke, balance problems); some had used TC before; device tested for 3-6 wks.	1) feeling safe 2) being positioned & supervised 3) being mobile 4) reflecting on new technology
<b>13. Parker et al., 2013</b>	USA	Examine the willingness of older adults with chronic pain to adopt mHealth technologies, & to identify participants' perceived barriers & facilitators to adopting mHealth.	Mixed method; questionnaire & 6 focus groups	Convenience sample	42 (>60 yrs., mean: 76.2 yrs.)	Hypothetical intervention via smartphone	Chronic pain patients; living independently or in assisted living facilities; urban; varied experience with ICTs	1) willingness to use mHealth 2) barriers to using mHealth 3) facilitators to using mHealth
<b>14. Pecina et al., 2011</b>	USA	Understanding elderly patients' feelings & perspectives toward telemonitoring.	Mixed-method; user testing followed by questionnaire & semistructured phone interviews	Random sample from larger telemonitoring study	20 (70-81yrs.)	Intel Health Guide [touchscreen, portable, attachable devices for monitoring of vital signs (e.g., blood pressure)]	Have used device between 8 & 17 weeks; had complex illnesses	1) Telemonitoring increases patient awareness of health 2) Telemonitoring prompts action 3) Telemonitoring provides peace of mind
<b>15. Pritchard &amp; Brittain, 2015</b>	UK	Investigating older people & caregivers' experiences using an alarm pendant; analysis focuses on some of the unanticipated social consequences of this device & the ways the social environment affects its use & function.	Focus groups, semistructured interviews, observations in a care home	Convenience sample; self-enrolment from age-related databases	47 (55-90 yrs.) & 9 informal caregivers (mostly family members)	Pendant alarm	Living at home; observations conducted in a care home with self-contained apartments equipped with pendant alarm; people without pendant-alarm experience included	1) Interrogating the utility of alarm pendants 2) Technological dehumanization 3) Rage against the (assistive) machine: alarm pendants & acts of resistance

<b>16. Shulver et al., 2017</b>	AUS	1) How do community-dwelling older people experience rehabilitation programs using TH? 2) How acceptable is TH to older people in the context of rehabilitation?	Semistructured interviews	Convenience sample; self-enrolment from "TH in the home" study	13 (60-92 yrs.) 3 spouses, & 1 caregiver present during interviews;	iPad with video conferencing tech & FitBit Activity monitor	Peri-urban; mobility issues; had undergone 8-wk. telerehabilitation program prior to study	1) convenience 2) promotion of motivation & self-awareness 3) fostering of positive therapeutic relationships 4) benefit of mastering technology of the young 5) no replacement for face-to-face therapy
<b>17. Steele et al., 2009</b>	AUS	Perceptions towards WSN designs; facilitate communication between users & researchers.	Exploratory study; 2 focus groups	Convenience sample from various elderly community groups	13 (>65 yrs.)	WSN [can be used for a variety of tasks (e.g., fall sensor, vital signs)]	Urban; living independently; no prior knowledge of WSN;	1) independence 2) perceived impact on the quality of life 3) concerns associated with WSNs 4) user's personal preferences; 5) design preferences 6) external factors