MY-AHA
Contract # 689592

My-AHA

Deliverable 2.14

Update on End user requirements

Editor:	USI (lead), DSHS, KAASA, ISMB
Deliverable nature:	Report (R)
Dissemination level: (Confidentiality)	Restricted to group (RE)
Contractual delivery date:	M18
Actual delivery date:	M18
Suggested readers:	Developers and content experts creating contents and software to be integrated into prototype of the my-AHA system.
Version:	1.0
Total number of pages:	26
Keywords:	Primary end-users, secondary stakeholders, requirements, attitudes and practices

Abstract

This deliverable D2.14 updates relevant primary end-user and secondary stakeholder requirements from D2.5.

A sample of 20 additional primary end-users (older adults with and without frailty) have been interviewed about different aspects of prevention (physical, cognitive, social and psychology domains, incl. topics like nutrition, depression, falls) as well as very relevant technology related topics like data privacy and protection, control and trust. Further, an additional set of 10 relevant secondary stakeholders (policy builders, health insurance, industry company, physician, NGOs, physiotherapists, professional care givers, nutritionist and ergo therapist) has been interviewed in detail regarding their attitudes towards the topics and domains mentioned above. Perspectives of primary and secondary stakeholders will be contrasted and negotiated for the design of my-AHA. In addition, we conducted a regression analysis for the quantitative data material collected in D2.5 in order to identify relevant factors predicting health technology use in older adults.

Finally, implications for the design of my-AHA were derived from qualitative and quantitative results presented in this deliverable.

Disclaimer

[Full project title] MY-AHA – my Active and Healthy **A**geing

[Short project title] MY-AHA

[Number and title of work-package] WP 2 Requirement Analysis & Practice-based Design

[Document title] Update of End-User Requirements

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Executive summary

Within the deliverable D2.14 we aim to update the findings in D2.5. Therefore, we conducted qualitative interviews and observations with 20 additional primary stakeholders and 10 additional secondary stakeholders. In addition to secondary stakeholders included in D2.5, the sample in D2.14 was extended by a nutritionist and an ergo therapist. Further, we conducted a statistical analysis of quantitative data material collected for D2.5. For the qualitative study we followed the same methodology as described in D2.5. While the quantitative study in D2.5 was rather of descriptive nature, in D2.14 we conducted a regression analysis in order to find predictors for health technology use.

Main results from the qualitative study in D2.14 show that primary and secondary stakeholders have considerably disparate perspectives with respect to well-being, independence, trust and health technology use. We contrast these perspectives and negotiate them for the design of my-AHA.

Main findings in the quantitative study in D2.14 illustrate that for older adults, technological factors like usability or accessibility are less important, while factors influencing physical activity engagement, for instance social support, physical appearance-related expectations, health-related expectations and physical activity per week significantly contributed to the prediction of self-reported health technology use per week.

Based on qualitative and quantitative results we derived several implications for the design of my-AHA, (1) build trust, (2) improve comprehensibility, (3) raise awareness, (4) apply an individual persuasion strategy, (5) strengthen autonomy, (6) support individual socio-technical fit, (7) integrate the social environment and (8) ease access to physical activity and healthy behaviour.

The results presented here and in D2.5 constitute an extensive investigation into practices and attitudes of older adults. At the same time they consider perspectives of secondary stakeholders. The design of my-AHA will build upon these findings to design a solution appropriate for all relevant stakeholders and promote long-term use of my-AHA.

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1 Introduction

Life expectancy rates are continuously increasing worldwide due to improvements in public health, nutrition, medicine, education and personal hygiene (Active Ageing, 2002; Barry, Mcgwire, & Porter, 2015; Centers for Disease Control and Prevention, 2013). This might endanger the socioeconomic systems of affected countries, as population demographics transit towards an ageing society with only few young citizens and economic costs associated with an ageing population grow. Healthcare professionals face demands to deliver improved care services under ever more constrained budgets. Thus, there is an increasing interest among policy makers and health care professionals alike in approaches and solutions that can help delay the need for healthcare services, prolong independent living, and support elderly people in what is now termed active healthy ageing (AHA) (Publications Office of the European Union, 2012; Rechel et al., 2013; Vines, Pritchard, Wright, Olivier, & Brittain, 2015). Researchers and technology developments have responded to the challenge to support prevention and health in the elderly through smart application of technologies (Haluza & Jungwirth, 2015; Stellefson et al., 2015) such as tele-monitoring, remote health services or self-monitoring with wearable devices (Publications Office of the European Union, 2012). These modern health technologies can provide more convenient health promotion compared to old-fashioned programs. Yet many research-based systems oriented towards supporting prevention and health for the elderly fail soon after research projects end, which has lead for further needs to improve sustainability and longevity of such systems (Di Pasquale, Padula, Scala, Biocca, & Paraciani, 2013; Jarman, 2014). Part of the problem is that health technologies are always deployed into ecosystems that encompass a variety of secondary stakeholders with contradictory perspectives and goals, for instance with respect to perceptions on well-being, motivation for prevention, data privacy, control and trust. On the other side, success and sustainability of health technologies relies on infrastructural requirements like financing models, legal frameworks or social infrastructures. Thus for a system to be sustainable requires not only a good technological design and willing users but also support from physicians, policy makers and local governments for integrating such new technologies into the extant systems of health and oversight.

Approaches such as user-centered and participatory design (PD) already suggest involving primary end-users and secondary stakeholders in the design and development of related health technologies (Pilemalm & Timpka, 2008; van Gemert-Pijnen et al., 2011). Nonetheless, current HCI literature on the design and development of health technologies for active and healthy ageing rarely considers primary and secondary stakeholder perspectives at the same time as a major part of the design of respective ICT-based solutions. We argue that development of technologies promoting health and prevention in elderly people hinges on ensuring that all relevant stakeholders are allowed to act together. In this deliverable, we present results from an exploratory interview study conducted with primary and a range of secondary stakeholders. Our objective was to identify, analyse and negotiate perspectives of end-users and stakeholders relevant for the design of AHA technologies. Further, we aimed at enhancing our understanding of predictors for the use of health technologies, established in D2.5, by applying a quantitative analysis approach.

The results illustrate (1) important contradictions, commonalities and interactions in end-user and stakeholder perspectives with respect to AHA technology use and how to negotiate them for a design of health technologies with sustainable impact on the corresponding healthcare ecosystem, (2) predictors for health technology use by older adults, and (3) specific implications for the design of My-AHA.

2 Objectives

The main objective of this deliverable will be to update results of D2.5. D2.5 already yielded extensive insights on attitudes and practices of older adults with respect to health technology use. However, D2.5 did not contrast perspectives of primary end users and secondary stakeholders. Moreover, we were only able to provide descriptive data for the quantitative study in D2.5, whereas in this deliverable we illustrate results from statistical analyses aiming to identify predictors for health technology use of older adults. Therefore, this deliverable will mainly build upon the results of D2.5, enhance our understanding of health technology use by older adults and derive specific implications for the design of My-AHA.

3 Methods

3.1 Research setting and data analysis in the qualitative study

In addition to participants presented in D 2.5, we established three different settings for the qualitative study with primary end users, (1) older adults living independently in a rural area named Bad Berleburg, (2) older adults living in a care home facility named Marienheim and (3) older adults living independently in the city of Siegen. Data collection and data analysis were analogous to the procedure described in D2.5.

Subsequently to primary end users interviewed in D 2.5, 20 primary end users with an average age of 75.5 years were interviewed. Table 1 provides an overview of all participants in this qualitative study, including participants interviewed for D 2.5 and D 2.14.

No.	ID	Sex	Age	IT-literacy	Health Status	Marital Status	Study phase
1	TN 1	male	74	Experienced	Physically fit	Lives with partner	
2	TN 2	female	75	Experienced	Physically fit	Lives alone	
3	TN 3	female	71	Experienced	Physically fit	Lives with partner	
4	TN 4	male	71	Experienced	Physically fit	Lives with partner	
5	TN 5	female		Experienced	Physically fit	Lives with partner	
6	TN 6	female	81	Experienced	Physically fit	Lives with partner	
7	TN 7	male	72	Experienced	Physically fit	Lives with partner	
8	TN 8	male	N/A	Unexperienced	No data yet	No data yet	
9	TN 9	female	74	Experienced	Physically impaired	Lives with partner	**Study phase 1**
10	TN 10	male	78	Experienced	Physically fit	Lives with partner	
11	TN 11	female	90	Unexperienced	Physically impaired	Lives with son	
12	TN 12	female	85	Experienced	Physically impaired	Lives alone	
13	TN 13	female	75	Experienced	Physically impaired	Lives with partner	
14	TN 14	female	83	Unexperienced	Physically fit	Lives alone	
15	TN 15	male	68	Experienced	Physically fit	Lives with partner	
16	TN 16	male	64	Experienced	Physically fit	Lives with partner	
17	TN 24	male	66	Experienced	Physically fit	Lives alone	
18	TN 25	male	76	Experienced	Physically fit	Lives with partner	
19	TN 26	female	72	Experienced	Physically fit	Lives with partner	
20	TN 27	male	66	Experienced	Physically fit	Lives with partner	
21	TN 28	male	66	Experienced	Physically fit	Lives with partner	
22	TN 29	female	79	Unexperienced	Physically fit	Lives alone	
23	TN 30	male	61	Experienced	Physically fit	Lives alone	
24	TN 31	male	70	Experienced	Physically fit	Lives with partner	
25	TN 32	male	74	Unexperienced	Physically fit	Lives with partner	
26	TN 33	female	71	Experienced	Physically impaired	Lives with partner	
27	TN 34	female	81	Unexperienced	Physically fit	Lives with son	**Study phase 2**
28	TN 35	male	72	Experienced	Physically impaired	Lives with partner	
29	TN 36	female	75	Unexperienced	Physically impaired	Lives alone	
30	TN 37	female	76	Experienced	Physically impaired	Lives with partner	
31	PN 38	female	85	Unexperienced	Physically impaired	Lives in a retirement home	
32	PN 39	female	81	Unexperienced	Physically impaired	Lives in a retirement home	
33	PN 40	female	92	Unexperienced	Physically impaired	Lives in a retirement home	
34	PN 41	male	84	Experienced	Physically fit	Lives in a retirement home	
35	PN 42	male	82	Experienced	Physically fit	Lives alone	
36	PN 43	male	81	Unexperienced	Physically impaired	Lives in a retirement home	

Table 1 Primary end users

Setting in Bad Berleburg: Bad Berleburg is a small city in North Rhine-Westphalia, Germany in the middle of the ”Rothaargebirge”, a mountain region up to 700 m above sea-level, which belongs to the district Siegen-Wittgenstein. The setting in this rural area combines guided fall prevention group activities (certified fall prevention courses) and the independent long-term use of technical devices and sensor systems in the daily life of seniors and at their home. The strong link between the group course and home-based technology should achieve a sustainable and long-term motivation and use of the fall prevention program, which positively contributes the to independence and mobility in the elderly life by lowering several fall risk factors like balance, strength, and others. A heterogeneous target group of nine older adults living independently in this rural area participate and meet weekly in the scope of the community centre Elsoff (Lukasgemeinde) in Bad Berleburg, where they take part in a fall prevention course conducted by two certified, experienced trainers. The scope of the community centre is stocked with a floor sensor (SensFloor) for analysing the way of walking and also with the iStoppFalls system. All participants live independently in this rural area and have an average age of 73.2 years (Number of participants = 9 , range = 61 - 81 years) and represent a heterogeneous target group composed of a balanced gender (4 male / 5 female) ranging from "fit" to pre-frail seniors. In addition to a couple which takes part at the course, the group consists of single-living seniors and some who lives together with the partner. In addition to the weekly fall prevention course, the seniors are playing balance games and accomplishing strength training with the iStoppFall system for prevention and fall risk measurement at home. By the use of the 6-meter-long grounded SensFloor, additional analyses are were carried out to determine gait patterns and the risk of falling. In combination to the guided coached group activities in the community centre, the elderly also use other technical devices and sensor systems in their everyday life and at home for general prevention of functional decline, e.g. related to physical activity, sleep and nutrition. In addition, the Smart Companion App [REF] and the my-AHA Cognitive Games which were used by the elderly, and following the seniors get an overview over their own vital parameters and health information such as sleep and nutritional behaviour or mobility status by using a fitness tracker, a sleep sensor and the nutrition app in their daily life. Furthermore, the iStoppFalls system is also installed in the senior’s home, where they carry out self-sufficient preventative exercises in their own homes in combination with the guided course. Every two weeks an additional technique-training-course related to tablet and smartphone use has takeing place in the community centre, to support the seniors in technical problems and to encourage the social exchange.

Setting in care home facility Marienheim: The care home facility Marienheim is a very modern and comfortable atmosphere that offers its residents the possibility to age healthy due to a wide variety of health courses. While there are caregivers that tend to the residents they are also allowed (and motivated) to still stay autonomous to a certain degree (i.e. shopping themselves, going for a walk). Six residents (3 female, 3 male) in the age of 81-92 (M=84,17) take part in our project permanently, while the project gained more interest in the facility. The participants had barely any knowledge with tablets and other variants of technology and are therefore getting trained once per week within the project.

Setting in Siegen: Siegen is a city in Germany with around 100 000 inhabitants in the south Westphalian part of North Rhine-Westphalia. It is located in the district of Siegen-Wittgenstein. The university town is the district seat and is ranked as a "higher centre" in the South Westphalian urban agglomeration. The participants are older adults living independently in the city centre or the neighbourhood of Siegen. The target group has an average age of 68.3 years (number of participants = 6, range = 64 – 76 years) with five male and one female participant. Except one, who lives alone, they share their homestead or flat with their partner. The seniors mainly do their household on their own and feel very comfortable in their homes. They are fully integrated in social life. They are members in different group activities e.g. sport groups or voluntary service and are all in good contact with their families and friends. The older adults are quite mobile and feel fit. For transportation they go by feet, use public transportation or their own car. Most of them have some basic knowledge about new media and computer usage. The older adults use technical devices in their everyday life and at home for general prevention of functional decline, e.g. related to physical activity and sleep. They use Apps like Medisana, MioGo or Beddit to get an overview over their own vital parameters and health information such as blood pressure and pulse, sleep or mobility status by using a fitness tracker, a sleep sensor and medical devices in their daily life. Furthermore, the iStoppFalls system is also installed in four homes, where they carry out self-sufficient preventative exercises in their own living room. The whole group meets approximately every four month for workshops or sharing their experiences. Single meetings

with one participant occur depending on their demand or technical problems, approximately every two months.

Further, we conducted 10 additional interviews with secondary stakeholders within the healthcare ecosystem. Besides organizations already interviewed in D 2.5, we conducted interviews with an nutritionist and an ergo therapist for D 2.14. Table 2 lists all secondary stakeholders included in the qualitative study (from D 2.5 and D 2.14).

Organization	Count
Nutritionist	1
Caregiver	3
Doctor	2
health insurance company	5
Policy builder	2
Physiotherapist	4
Ergotherapist	1
NGO	3
Business company	1

Table 2 Secondary stakeholders

Based on the coded data material we derived different primary end user and secondary stakeholder perspectives on prevention, health and technology. In this deliverable, the first part of the qualitative analysis will present contradictions and agreements of primary and secondary stakeholder perspectives relevant for technology-supported AHA. In a second part, we will illustrate additional insights into the practices and attitudes of older adults with respect to health technology use, collected within the three settings.

3.2 Research setting and data analysis in the quantitative study

A detailed description of the setting and data collection for the quantitative study can be found in D 2.5. In addition to the analysis conducted in D 2.5 we used the data material for further analyses to identify predictors for technology use in older adults. Based on the total of 201 completed questionnaires, 62 participants (11 female) were included in the data analysis, after excluding extreme values and outliers, applying several filters and excluding incomplete questionnaires. Applied filters were: younger than 100 years, reported less than 30 years of education, reported less than 105 hours of physical activity per week, and reported less than 168 hours per week technology use. Participants scoring above the cut-off for one or more of these filters were excluded from the analyses. Participants mean age was 60.6 ± 8.3, with 13.8 ± 4.3 years of education.

A linear regression analysis to evaluate the value of factors from the technology acceptance model (TAM) by Davis et al. (Davis, Bagozzi, & Warshaw, 1989) and the social cognitive theory (SCT) by Bandura (Bandura, 1986) on self-reported technology use per week was conducted. In the prediction of self-reported technology use per week, technology experience, ease of use and usefulness were used as TAM factors, while self-efficacy, barriers, health-related expectations, physical appearance-related expectations and social support were applied as SCT factors. Additionally, we included activity per week as a variable to measure its value in the prediction of self-reported technology use. All predictors were entered into the regression equation in the same step. Diagnostic tests of tolerance and variance inflation revealed all of the measures fell within acceptable ranges of collinearity (Variance Inflation Factors < 2.5).

4 Qualitative study: Contradictions and agreements of primary and secondary stakeholder perspectives on technology-supported AHA

4.1 Perspectives on health and prevention

While perspectives on what entails Active and Healthy Aging vary, participants in our study consistently highlighted four components: (1) social participation, (2) physical activity, (3) nutrition and (4) sleep. Both

primary and secondary stakeholders shared common perspectives on social participation and physical activity, but their perspectives on nutrition and sleep were rather different.

4.1.1 Agreements on physical activity & social participation

In our study, we learned that elderly people and secondary stakeholders understand AHA primarily in light of physical activity and social participation. Elderly people understand AHA as a convenient means to maintain social contacts and they would welcome technology to support this activity:

> *"Well, I need social contacts! […] This is why I want to stay in my own home as long as possible, and of course, I appreciate any technology that can help me with staying healthy longer […]." (TN 12, female, 85 years).*

Further, some elderly people see a distinct association between social participation and physical activity that motivates them in AHA.

> *"The reason why I engage in activity is that I feel an obligation to my friends and family" (TN 30, male, 61 years).*

Secondary stakeholders share these perspectives and emphasize the importance of social participation and physical activity from a professional point of view:

> *"Physical activity and social participation have a strong correlation. If someone lives alone at home, you can see that he takes considerably less care of his physical health. […]" (Doctor).*

4.1.2 Disagreements on sleep and nutrition

Both the elderly people and secondary stakeholders understand nutrition as an important factor for AHA. However, their perspectives on what healthy nutrition ought to look like deviate considerably. For instance, elderly people mentioned how important it was for them to enjoy food. For many eating needed to remain a pleasurable experience where the demands of healthy nutrition were perceived in conflict with this desire:

> *"Of course, healthy nutrition is important to me. However, it clearly contradicts my lust for food […]." (TN 7, male, 72 years).*

Additionally, some remarked that they do not appreciate suggestions and recommendations regarding food and nutrition, as they feel patronized by that:

> *"Yes, it [healthy nutrition] has a specific importance. However, it is not so important to me that I would allow for someone to tell me what to eat and what not. I don't like to be patronized" (TN 1, male, 74 years).*

This stands in stark contrast to perspectives of secondary stakeholders, who shared the common opinion that elderly people lack the physical and cognitive capabilities to eat in a healthy manner and require more guidance and support in healthy cooking and nutrition:

> *"Yes indeed, […] with age capabilities to cook properly every day decrease. We could do more here. For example, collaborative cooking communities or support and guidance from professionals." (Care-giver).*

Thus while the secondary stakeholders insisted that nutrition must be a focus for system design, the primary users expressed a great deal of caution about this aspect of the system.

Sleep was another aspect of daily life that generated a diversity of opinions both between and among the stakeholder groups. About half of our elderly participants did not see sleep as an important parameter for AHA:

"Of course one night you sleep very well and another night you don't, but I don't see any reason in that to be concerned about my health" (TN 42, male, 82 years).

For the other half of elderly people, sleep was a factor they associate with personal well-being:

"If I really managed to sleep through the night, I am a totally different person and happier the next day." (TN 13, female, 75 years).

In contrast, secondary stakeholders have very consistent perspectives on the positive effects of sleep for AHA:

"sleep is a very important factor and it related directly to health. Sleep deficit does not maintain your health or well-being. Sleep should be considered as a factor when treating older adults with diseases" (health insurance company).

Once again, we see that while there are clear and important factors for AHA from a clinical perspective, the experiential nature of these aspects of daily life for the primary users often put the stakeholder groups in conflict.

4.2 Motivation for prevention

For prevention measures to succeed, motivation is key. Motivation for disease prevention, especially in elderly people, is a highly individual and situational multidimensional construct. In our study, we found that primary end users and secondary stakeholders shared a common understanding that family, social participation, awareness and independence are important factors for motivation in the context of AHA. The major disagreements primarily emerged in the discussions of financial incentives and structures for implementation of AHA.

4.2.1 Agreements on the importance of family and friends

The desire to maintain the ability to participate with family and relatives drives many elderly people to perform disease prevention activities:

"Generally speaking, I am not that interested in fall prevention. However, when I carried my grandchild up the stairs and felt that I am not that secure anymore in going up the stairs, I thought that I need to do something about it, so I can continue to be there for my grandchild" (TN 32, male, 74 years).

This was especially evident for participants who lived with family and enjoyed a larger family and social circles:

"[…] top priority are my kids, my grandchildren, my wife of course. I want to be able to participate and keep up with them." (TN 10, male, 78 years).

Secondary stakeholders also understood that familial connections can act as crucial enablers for disease prevention in elderly people and that prevention programs should address this topic more intensely.

"I believe you need to start health education very early to set a foundation for disease prevention. And I do not only mean that children should be educated in kindergarden or school. That is not enough. You have to reach the parents somehow and convince them" (Nutritionist).

Alongside family, strong social relationships and social participation are convincing criteria from the perspective of elderly people in our sample to follow prevention measures:

"[…] social contacts are the most important thing. With age you learn to appreciate this. For instance, I live alone. If I lose my mobility and would not be able to leave the house anymore to meet with friends, I would want to move to a care home facility. […]. It [social contacts] is a very important aspect for health." (TN 2, female, 75 years).

This became especially important for participants who lived alone and did not have much family nearby. Here participation in organized social activities gained in importance:

"[…] by playing bridge […] you are not alone, you belong to a community, and you have company for lunch and dinner. You don't have to go to your room and watch TV alone. It is much more enjoyable to do things together than sitting in your room alone watching TV." (TN 12, female, 85 years).

Secondary stakeholders also emphasized the risk of social isolation and the importance of social participation in elderly people. They understood social participation as therapy and potential cure for health problems in elderly people:

"Human contacts are a form of therapy. Formerly you had that for example in cabs or at the hairdresser. This has gone in today's society, which has become very cold. Health issues are strongly intermeshed with that [social contacts]." (Physiotherapist).

The promotion of awareness and the consequences that can follow from an unhealthy lifestyle seem to be valid factors for primary end users and secondary stakeholders, determining another form of motivation for practicing health prevention activities. Elderly people are aware of family members or relatives who followed an unhealthy lifestyle and had to deal with the consequences:

"There are bad examples [for an unhealthy lifestyle]. My father died very young. […]. He is my motivator for acting more healthy." (TN 15, male, 68 years).

Accordingly, many secondary stakeholders discussed how such personal examples could become effective motivators:

"You motivate elderly people by making it very clear to them that they will have to move to a care home facility when they lose their mobility and that life quality is much higher with sufficient mobility." (Doctor).

Most of the primary stakeholder concerns about maintaining social ties and participating in social events hinged on the ability to remain independent. This then became the single biggest motivator for health promotion:

"The reason I take care of my health is that I want to be able stand on my legs independently and upright and walk wherever I want." (TN 10, male, 78 years).

From the secondary stakeholder point of view, independence is crucial in health promotion and in reduction of health costs overall as these two factors are seen as interdependent:

"With increasing dependency, motivation for health prevention decreases and therefore it will be much harder to take influence on the motivation of elderly people." (Caregiver).

4.2.2 Disagreements on financial incentives as motivators

A prominent factor in our data was financial incentives and constraints associated with health. Monetary incentives are a common method in health promotion. However, they are rarely discussed as influencing factors in the design process of health technologies. Our analysis showed that primary end users associate wealth with personal health:

"Maintain healthy, physically and mentally. It might be that I return to work soon. […]. I can continue to work as much as I want and earn as much money as I want. I need to be healthy for that. Health is the most important thing." (TN 16, male, 64 years).

There was significant diversity of perspectives among caregivers, physiotherapists and policy builders regarding monetary incentives to promote health in elderly people. For instance, caregivers and physiotherapists have very contradictive perspectives on monetary incentives. Caregivers were willing to use rewards for elderly people for acting healthy:

"[…] it is a score system, where you can collect 100 points. Points can be collected by doing different activities in different topics such as mobility, strength, cognition, endurance and enjoyment of life. Once a person collected 100 points he will be rewarded with a 10 € voucher, valid for the city gallery […]. (Caregiver).

On the contrary, physiotherapists would vouch for not offering health interventions free of charge, so that they become of value for elderly people.

"[…] If you offer something [prevention measure] that is entirely free of charge, it is not as important to someone as when you paid money for it." (Physiotherapist).

Policy builders' perspective on this matter pinpoints the fact that elderly people often lack access to preventive measures and initiatives, for instance, due to insufficient funds.

"[…] I might need to reduce barriers first, like the fact that as an elderly person I maybe cannot afford participating in a sports club. He might put his existential fears first. It is our job as society to find alternative ways to lead elderly people into prevention measures" (Policy builder).

From their perspective, it is rather more important to find alternative ways to engage and motivate socially disadvantaged people for prevention measures than offer highly complex approaches that fulfill newest standards for the middle class:

"[…] develop prevention activities in the context of social integration for instance. Make them free of charge, offer them in quartiers. That would increase the motivation of these [socially disadvantaged] people more sustainably than offering new fancy prevention methods for middle class elderlies, who probably have a higher motivation to test such programs as they can afford them." (policy builder).

Here we see that design decisions might differ significantly depending on the stakeholders involved. Clearly, the secondary stakeholders that engaged with the elderly directly, such as caregivers or physiotherapists, thought of financial incentives as motivational factors that could be directly manipulated. Policy builders in contrast were concerned with bigger structural issues such as access to healthcare. Yet from a design point of view, these perspectives would have to be negotiated carefully. After all, the very meaning of financial incentives might change significantly depending on the financial structures in place to enable the use of the AHA system in the first place.

4.3 Perceived Benefits and drawbacks of technology supported AHA

Long-term use of health technologies requires that technological solutions address benefits and usefulness from all stakeholder perspectives very explicitly. Our study revealed that both, primary end users and secondary stakeholders agree upon three benefits and two drawbacks of health technology use. They believe that monitoring health-related objectives like physical activity, improved security like obstacle warnings and effort reduction as in reduced necessity to visit doctors are major benefits. On the other hand, primary end users and secondary stakeholders fear that technology use will increase the risk of dependency in terms of overreliance and impair elderly peoples' self-awareness, as they might unlearn to listen to natural body signals. Further, we were able to reveal that primary end users and secondary stakeholders disagree on the

advantages of improved health literacy in elderly people and the benefits, technology might provide for communication between elderly people and professionals.

4.3.1 Agreements on benefits

Many primary end users valued the possibility to self-track specific aspects of the body, such as sleep or breathing:

> *"Yes well, using such things [health technologies] would allow me to see how my health condition is. I would be interested in that." (TN 32, male, 74 years).*

The benefits for some participants lie in the comfort and convenience of digital tracking of things such as measuring walking distance with electronic pedometers compared to old fashioned paper and pencil solutions:

> *"I think, yes. In the long run I would use it. After all, I would monitor myself on a regular basis, like seeing how many steps I have taken and so on. Keeping track of such things would be quite comfortable with technology." (TN 16, male, 64 years).*

The health data produced by activity tracking also clearly represented a host of opportunities for many secondary stakeholders:

> *"[…] I think it can be very useful, measuring the pulse, blood pressure, etc. For instance, I would see whether the patient achieved the set distance goal or I need to encourage him more, with individual measurements […]." (Doctor).*

Another important factor for usefulness of health technologies primary end users and secondary stakeholders agreed on is security. Some elderly people see benefit in technology use, as it might prevent them from physical harm:

> *"If I would have a device that warns me when I should pay attention to my environment. That would be great!" (TN 5, female, 78 years).*

Other elderly participants saw in technology a useful minder that could help them to find their way home or tell other people their location to pick them up:

> *"With age, disorders become more frequent, orientation for instance […]. I would find it useful if relatives could find my current location, in case I lose my orientation." (TN 10, male, 78 years).*

Secondary stakeholders also agreed that technology can prevent physical harm and provide support for disorientation and helplessness.

> *"Technology might be useful in situations where they cannot act self-determined anymore or when they lost orientation and wander around." (NGO).*

Finally, primary end users see a major benefit of health technologies in the potential to reduce health-related efforts like going to the doctor or hospital less frequently.

> *"[…] that [health measurements collected by technology] may be very useful, so that you don't need go to the doctor often […]." (TN 2, female, 75 years).*

Secondary stakeholders agree and welcome technology use for these purposes:

"[…] generally it [working over the internet] is very convenient. For many things you don't need patients to be on-site. Especially with elderly people, many things can be done via Skype for instance." (Physiotherapist).

Thus, AHA systems were seen as a way to gain more support in day-to-day functioning and to reduce interactions with the health system – a clear benefit seen from all stakeholders.

4.3.2 Agreements on drawbacks

Yet acceptance of technology was not universal and with good reason. Many of the elderly participants were cautious in using health technologies, as they feared this could lead to being controlled by technologies, institutions or other people and to loss of independence.

"I told myself, I don't wanna change anything with respect to my health. I am healthy and I feel well. Using such technologies would increase the risk for me to be influenced by health technologies and subsequently change my behaviour in the wrong direction. I don't want to follow instructions of technology, I rather listen to my own body." (TN 28, male, 66 years).

Given the clear potential of personal health data collection and the sheer scale of access to the intimate daily functioning of the elderly, secondary stakeholders agree that data leakage and even unintentional control could be a risk and wished for clear limits to avoid external control by institutions or other people:

"There have to be ethical limits. No one wants to be externally controlled. I am very concerned about that." (NGO).

Alongside concerns of external control, many of our elderly participants were also concerned with potential impairment of self-awareness, as they would rely too much on the data and recommendations provided by the technologies. Health systems can produce convenient data about sleep or walking but many crucial activities would of course remain unmeasured and potentially could become deprioritized:

[…] I would have a problem with controlling myself all the time. I would be concerned with data about my health most of the time. It could irritate me easily, for instance if it tells me my pulse is too high and I would not know what it means or what to do. […]." (TN 4, male, 71 years).

Despite the excitement around potential for health data, secondary stakeholders also shared the concern that elderly people could focus too much on technology and stop listening to natural signals of their body:

"yes indeed. This can go in the wrong direction. If such health technologies tell me twice the day that my blood pressure is too high, I might start to worry as an older adults." (NGO).

4.3.3 Disagreements on drawbacks

A major factor for elderly end users to use health technologies is the possibility to improve their health literacy:

"[…] I would use technology to gather more information on healthy lifestyle and health in general." (TN 10, male, 78 years).

Some thought this could also strengthen their position in their interactions with health professionals:

"Yes, maybe this technology could support me if I need to assert myself at the doctor's or at some other organization. I'd be able to say we haven't taken this and that into account and maybe we could try such-and-such to get to the bottom of the problem." (TN 13, female, 75 years).

Despite the support for health literacy clearly expressed in recent EU policy statements, there was considerable disagreement from the secondary stakeholders about the value of increased health literacy. For example, doctors and physiotherapists feared an increased resistance to advice in elderly people, which would aggravate professional health services:

> *"It is like you ask Dr. Google all the time. It is not good, if people rely on their apps or the information in the internet more than on their doctor's advice." (Physiotherapist). The policy builders were less negative, but also acknowledged this issue: "In general it is the right approach to increase health literacy in elderly people. However, we should prevent situations where the patient thinks he knows better than the professional does" (policy builder).*

Yet perhaps the strongest disagreement of all we discovered around the most common of IT system features – reminders. Secondary stakeholders anticipated improved communication with professionals and patients and were keen on the possibility to send reminders to their patients:

> *"Interconnection is important! For instance, if I want to share information with my team or patients, I could create a virtual communication space. I would be able to remind them frequently, like five times a day to take care of things." (Physiotherapist).*

In contrast, primary end users explicitly mentioned during our interviews that they are not fond of such reminders and notifications. In fact, the reaction was often so negative that it became a barrier for using such technologies:

> *"I value my autonomy. I do not let myself be influenced by any kind of information or reminders telling to do this or that." (TN 28, male, 66 years).*

Primary end users acknowledged the dangers of failing memory but constant reminders were strongly perceived as problematic loss of independence.

4.4 Data privacy, control and trust

Data privacy, personal control and trust are crucial considerations for the design of AHA health systems given the prominence of personal health data and the flow of this data between primary and secondary stakeholders. Primary and secondary stakeholders had similar perspectives on data privacy. However, their perspectives differed in terms of trust in institutions and control over personal health data. In fact, these perspectives were so divergent among primary and secondary stakeholders that we could not simply align them into agreements and disagreements. Instead, what we found was that concerns about data privacy and trust in the context of technology use for AHA build upon pre-existing relationships between primary end users and secondary stakeholders and that the desire for data control derives from this. These relationships can at times require negotiations of new accountabilities when technology use for AHA support enters the field.

All primary end users in our study had major concerns in sharing their health data with HIC's, mainly because they feared increased health insurance contributions:

> *"When you talk about health related data, data privacy becomes much more important compared to other data. Sharing health related data with e.g. health insurance agencies can be harmful for yourself" (TN 15, male, 68 years).*

Noticeably, many secondary stakeholders shared these concerns:

> *"I think it is very important, there is a high risk for data abuse and increased health insurance contributions when sharing health data with health insurance companies" (Doctor).*

Such concerns may arise due to pre-existing and somewhat adversarial relationships primary end users and secondary stakeholders like doctors or physicians have with HIC's. While end users, doctors and physicians are reliant on subsidies and payments for healthcare products and services, HIC's need to be economical and minimize expenditures. These goals are often in conflict and data sharing can be seen as too invasive. Besides, many of the fears and concerns about data privacy are also fueled by and derived from the media:

> *"If you look at the media in the last two years, you see how private data is being abused and where you can buy all that data! […]" (Policy builder).*

Having said this, trust of many elderly people and secondary stakeholders in health institutions is corrupted and relationships with HIC's therefore have no real foundation of trust.

Health technologies for AHA support need to build upon these pre-existing relationships and perspectives and can aggravate data privacy concerns and mistrust even more, as elderly people, and in many cases also secondary stakeholders, lack IT-literacy to understand how technology works and how health data is being processed:

> *"I am quite sensitive in that area [personal data]. I barely upload personal data in the internet, for the reason I do not know and do not understand who uses the data and what happens with them." (TN 1, male, 74 years).*

Despite the admitted lack of literacy, many end-users demanded control over their health data disclosure:

> *"[data] transfer? Yes, but under the condition that I will be asked for permission up front. The owner of that data should decide whether they may be transferred or not. I expect that to be sorted out before I use such technologies." (TN 4, male, 71 years).*

This need was keenly understood by many of the secondary stakeholders that argued for increased transparency of health data processing:

> *"[To trust in technology] it would take very crystal clear, transparent structures on how data is being handled." (Caregiver).*

Full control over health data and determination about who can see or use that data are key factors for both stakeholder groups for long-term health technology use. This sentiment is shared by prior research and current policy reports (Latulipe et al., 2015; Publications Office of the European Union, 2012; Schulz et al., 2015) Policy builders expressed significant support for enabling elderly people with more control over their health data:

> *"[…] and people should have the possibility to inform themselves and come to a decision, whether they want that [sharing health data] or not." (Policy builder).*

By doing so, policy intends to build a foundation for long-term health technology use in elderly people. Our participants illustrated clearly the need for such mechanisms, but still policy needs to tackle broader issues on an infrastructural level to promote sustainable impacts of health technologies on the healthcare ecosystem. Promoting long-term use by elderly people through means of health data control is only one part of it.

5 Qualitative study: Discussion of contradictions and agreements

Our results show that there are major contradictions across various issues. However, it seems that a bigger set of problems are the fundamentally different conceptions of central notions such as independence and well-being among both primary and secondary stakeholders. While everybody agrees on the importance of independence and well-being, many of the disagreements, presented in this paper, stem from the different meanings of both concepts for elderly people and secondary stakeholders. As most of the current literature

and research on the design and development of health technologies for AHA support concentrates on either primary end users or secondary stakeholders (Fritz, Huang, Murphy, & Zimmermann, 2014; Gerling, Mandryk, & Linehan, 2015; Schorch, Wan, Randall, & Wulf, 2016; Uzor & Baillie, 2014), exposure of such deceptive agreements and different understandings is critical. In what follows, we discuss deceptive agreements and the sources of disagreements around independence and well-being. We then consider how these can be negotiated for the design of health technologies and what political and infrastructural requirements are necessary for the sustainable deployment of such technologies into the healthcare ecosystem.

5.1 Conceptions of independence

Our data demonstrate that primary and secondary stakeholders are in significant agreement about the importance of supporting independence as a major motivating factor for health promotion and disease prevention activities. We then detailed significant disagreement about factors such as health-literacy and technology design functionalities such as reminders both seen as key to maintaining independence but by different stakeholders. These disagreements, we argue, stem from different conceptions of the notion of independence, making the stated agreement on the subject deceptive.

5.1.1 Health Literacy

Improvements in health literacy are supported as a matter of EU policy and this policy seems to align with the attitudes of the elderly in our study. For the elderly, health literacy was important to their sense of independence. They wished to understand check-up procedures and their outcomes, and to be able to demand alternative procedures, in case of doubt. Health literacy in this context was seen as a way to shift from passive receipt of medical instruction to active involvement in own health. As Lorenzen-Huber et al (2011) found, elderly people do not want to be passively monitored subjects, but desire to be treated as equals (Lorenzen-Huber, Boutain, Camp, Shankar, & Connelly, 2011).

This was cause for significant concern about the way health literacy might be obtained expressed by secondary stakeholders such as caretakers, physiotherapists or doctors who worried about increased resistance to medical advice in elderly people. These concerns also referred to inaccurate or false information on the internet and inability to control the quality of information their patients accessed. Our results indicate that doctors worried their professional work would become more complicated with elderly people who felt more informed. Doctors insisted that it was important for the elderly people to accept guidance and recommendations and did not see these concerns in conflict with promotion of independence.

For the design of AHA technologies, the challenge lies in addressing such desires and concerns by perhaps creating a space for collaboration and equality with respect to personal health between elderly people and professionals by means of technology. For instance, health professionals could send personalized health information to their patients' health devices or applications, if requested, instead of the elderly relying on information gleaned from the Internet. Technology could mediate the process of improving health literacy in elderly people, by enabling health professionals to control the quality of health information their patients receive and read.

5.1.2 Reminders as a feature or a problem

Another surprising source of disagreement between primary and secondary stakeholders was reminders – a common feature of all AHA technologies. In our study, many participants were not very fond of this functionality. They understand the intention and the ostensible value in supporting healthy behavior. Yet, receiving constant reminders about what to eat or when to eat, was perceived as the very opposite of independence, being interpreted instead as patronizing. The elderly people in our study were sensitive to and wanted control over the frequency and content of reminders. For the elderly in our study, reminders were seen as an intrusion, a questioning of their own abilities and at times even an over-emphasis on formal conceptions of what constitutes healthy behavior.

In stark contrast, most secondary stakeholders saw reminders as a useful tool to improve the efficiency of their professional work. They would use such functions frequently to influence the behavior of their patients. Here reminder functionalities were seen as a means to support the elderly and to help maintain independence. To the health professionals then, reminders were a way to mitigate their own distrust in the ability of the

elderly to adhere to medical standards of healthy living. Here independence was interpreted as consistent performance of rote tasks, with reminders used for behavioral modification if necessary.

The design challenge here is to provide a compromise between functionality and user acceptance. While reminders can indeed be useful for elderly people, we learned that it is important to (1) limit the possibility of professionals to deliver them at any time and (2) take into account the sensitivity of elderly people towards the frequency and contents of such reminders. For instance, on a very simple level, health technologies should provide options to enable, disable or restrict reminders from health professionals in order to provide control to elderly people. Ideally, reminders could be designed to address individual preferences and personalities of the end users as well (Smith, Dennis, & Masthoff, 2016). After all, frequency, presentation and content are highly individual factors and determine whether reminders are perceived as useful or annoying (Bailey, Konstan, & Carlis, 2001; Goldstein et al., 2014; Haberer et al., 2012). These points require collaboration of primary and secondary stakeholders and the mediation and moderation by designers, to find an appropriate ratio of functionality, content personalization and control.

5.2 Differing conceptions of well-being

Well-being is an important factor in the success of AHA but we observed that primary and secondary stakeholders partly disagree on what constitutes well-being. For secondary stakeholders well-being is mainly associated with measureable physical and cognitive health, for instance data on physical activity or nutrition. Here, they tend to follow a deficit approach, focusing more on impairments, limitations and restrictions of elderly people and how these deficits can be treated with prevention and intervention programs. In contrast, elderly people in our study associate well-being with enjoying life through means of social participation, independence and self-determination, rather than trying to meet appropriate health measures all the time. There is no doubt, that from a medical point of view nutrition, sleep or physical activity are major factors that influence individual health. Technology supports convenient measurement of these factors through monitoring nutrition intake, sleep patterns and physical activity. These measures then come to be interpreted as evidence of well-being and of behavior that would ensure physical health.

Yet well-being is not merely a result of measured behaviors but an individual feeling and is not compulsory associated with such health factors. Most of current health technologies for AHA support follow the same pattern and provide prevention and intervention measures like activity or nutrition monitoring with the stated intention to improve elderly peoples' well-being. The elderly in our study, however, insisted that well-being was associated with enjoyable activities even if these were clearly less healthy. To them, no amount of healthy nutrition could substitute for the joy of a shared if potentially unhealthy meal. Here we see the distinction between measured and experiential conceptions of well-being. From a design point of view both conceptions ought to be considered thus accounting for the individuality of elderly people and the requirements of health professionals. By doing so, we might have a greater chance that elderly people are willing to integrate our technological solutions for long-term AHA support into their daily routines.

5.3 Determinants for trust in health technologies

Control and trust are important factors for elderly people, in the context of AHA and technology use (Braun, 2013; Heart & Kalderon, 2013; Lee, Myrick, D'Ambrosio, Coughlin, & de Weck, 2013; Miller & Bell, 2012; M. G. Morris & Venkatesh, 2000). Our study shows that elderly peoples' trust in health technologies may strongly depend on the reputation of secondary stakeholders. Seniors are willing to use new health technologies under the condition that collected health data is only processed to trusted secondary stakeholders like physicians and that health data processing is transparent. There is a considerable distrust in HIC's, which is induced by the fear of increased health insurance contributions due to the monitoring of unhealthy behavior. In fact, our results show that some secondary stakeholders have indeed a strong desire to exploit health data more largely. However, our data also illustrates that elderly people imagine the capabilities of HIC's to exploit and use health data to be much more sophisticated as they actually are. Another perspective here is the insight that elderly peoples' intention to use health technologies seems to be heavily affected by recommendations of health professionals. Cimperman et al (2013) also found recommendations of relatives, friends or professionals to have major influence on trust in technologies by elderly people (Cimperman, Brenčič, Trkman, & Stanonik, 2013). For long-term health technology use by elderly people, it is therefore a noticeable factor that health professionals perceive explicit value by means of improved professional health services and health benefits for elderly people when using health technologies,

so they would recommend them to their patients. Having said this, our empirical analysis implies that health professionals tend to refuse health technology use by elderly people for reasons of impaired self-awareness in elderly people. Such concerns, fears and misunderstandings need to be negotiated among all relevant stakeholders. For instance, health technologies should guarantee that under no circumstances personal health data will be distributed to third parties and provide concepts and functionalities to ensure full control over health data by elderly people. To reduce secondary stakeholders' concerns about impaired self-awareness, health technologies should provide a space for the involvement of secondary stakeholders, so that they can keep track of their patients' health technology use and communicate measurements to promote self-awareness.

5.4 Political will and the policy framework

No matter the quality and ingenuity of AHA technologies, their success and long-term sustainability largely relies on policies and reimbursement. Monetary incentives and financial reimbursements are prominently discussed controversial topics in the area of health promotion (S. S. Morris, Flores, Olinto, & Medina, 2004; Volpp, Asch, Galvin, & Loewenstein, 2011). For the success and sustainability of health technologies for AHA support in the EU, financial reimbursement seems to be of utmost importance. In most parts of Europe, people pay monthly contributions to the health care system. In return, the health care system pays for necessary health check-ups and treatments. European residents usually expect partly or full compensations for health expenditures. However, in some countries like Germany, Switzerland or France the health care system defines a limited set of health care products and services that are available for monetary compensation. People must pay for products and services, not listed in this catalogue, on their own, which happens rarely for that reason. As designers of health technologies, we therefore face two problems: (1) design technical solutions effective and appropriate for the target group and stakeholders (2) ensure sustainable uptake of such health technologies within the relevant healthcare ecosystem. Due to the structure of healthcare systems in Europe, the latter depends heavily on the willingness of governments to subsidize health technologies and provide incentives to people who need such technologies for reasons of prevention or intervention. Therefore, as designers we have no direct influence on this aspect of the sustainability of such health technologies. Instead, the policy maker also paves the way for sustainable use of ICT-based solutions to support AHA in elderly people.

This is where we come full circle, as sustainable health technologies demand for the infrastructures and frameworks for successful integration of such technologies into the daily life routines of elderly people and relevant secondary stakeholders. This includes for instance, financing models with respect to subsidizing health technologies for elderly people, legal frameworks with respect to concepts for data privacy and data control to empower elderly people, and social infrastructures with respect to participation and integration opportunities, so that loneliness and social isolation become less crucial factors for impaired health. Foundations to such tasks need to be deployed by political stakeholders and policy makers. Designers are only able to take them up by mediating, moderating and negotiating between end-users and all relevant stakeholders in addressing their needs and demands. However, it is the insight of such design activities, presented here that is needed in a first step to (1) derive an appropriate system design and (2) identify recommendations for action, so that in a second step political stakeholders can make decisions and initiate changes that allow for a sustainable impact of health technologies on the relevant healthcare ecosystem. Therefore, we suggest that the design of health technologies for elderly people should strongly recollect on the strengths and benefits of PD, which provides a space for collaboration and cooperation between relevant stakeholders and enable designers to mediate and moderate between them in order to identify, analyse and negotiate contradictive perspectives, different conceptions and political framework conditions.

6 Quantitative study: Analysis of technology use in older adults

6.1 Predictors for technology use in older adults

6.1.1 Descriptive statistics

This section presents the means and standard deviations for participants' scores on technology experience, ease of use, usefulness, self-efficacy, barriers, activity per week, health-related expectations, physical appearance-related expectations, and self-reported technology use and social support.

Variables	Mean	SD
Technology use (hours)	79,1	69,5
Technology experience	8,7	3,1
ease of use	4,5	0,8
usefulness	4,3	1,7
self-efficacy	4,5	1,2
barriers	2,1	0,4
reported physical activity per week (hours)	25,8	22,7
social support	1,6	0,6
health-related expectations	4,3	0,7
Physical appearance-related expectations	3,9	0,9

Table 3 Descriptive values for the predictor variables used in the regression analysis

6.1.2 Correlation analysis

A pearson's correlation analysis between technology use and the TAM and SCT variables, which were later added in the regression model was initially applied. In total, HTU showed significant positive (but very low) correlations only with physical activity per week (r=.322) and social support (r=.284). Interestingly, there was also a negative correlation between HTU and physical appearance-related outcomes.

6.1.3 Regression analysis

Finally, in order to examine the relative contributions of technology experience, ease of use, usefulness, self-efficacy, barriers, activity per week, health-related expectations, physical appearance-related expectations and social support in the prediction of technology use per week, a regression analysis was conducted. All predictor variables were entered in the same step of the analysis, resulting in 39.5% explained variance in self-reported technology use per week. Technology experience, ease of use, usefulness, self-efficacy, and barriers, failed to contribute significantly to the prediction of self-reported technology use per week. Beta weights for the regression equation indicated that physical activity per week ($\beta = .40$, $p < .01$), social support ($\beta = .29$, $p < .05$), health-related expectations ($\beta = .44$, $p < .05$) and physical appearance -related expectations ($\beta = -.47$, $p < .001$) made significant contributions to the prediction of self-reported technology use per week.

6.2 Discussion of quantitative analysis

The regression analysis showed that usefulness, ease-of-use and technology experience were not significant predictors of health technology use (HTU). This may seem surprising at first since previous research has often underlined the importance of such technology-related factors for HTU (Ammenwerth, Iller, & Mahler, 2006; Orruño, Gagnon, Asua, & Abdeljelil, 2011). However, at most of these studies, these factors have been examined 'separately', meaning that they were rarely put in models together with SCT or other factors. According to our results, it may be likely that when considering SCT and TAM factors together, social cognitive factors are more relevant to predict HTU in older adults. A reason might be that older adults perceive health technologies merely as tools supporting their transition to a healthy lifestyle and not as tools to support physical activity related goals. Such indications and the fact that the variable "expectations regarding physical appearance" in our regression analysis was negatively associated with HTU, are in line with previous research stating that older adults' motivation to lead a healthy lifestyle and exercise is not to look good, but rather feel good (Reboussin et al., 2000). For that reason, health-related expectations was one of the significant predictors in the regression model. Finally, the important role of social support is confirmed by our findings as well, as it has been found to be a significant predictor for HTU (Scarapicchia, Amireault, Faulkner, & Sabiston, 2017).

The most surprising finding of the regression analysis is that self-efficacy did not make a significant contribution to our HTU model, despite it being considered as one of the most important predictors for all kinds of behaviors (Amireault, Godin, & Vézina-Im, 2013). However, since physical activity was one of the significant predictors and it is known that self-efficacy is crucial for physical activity, it is likely that this indirect relationship explains this finding.

Research has shown that HTU can be a mediator for physical activity (Graham, Hipp, Marshall, & Kerr, 2014; Rimmer, Riley, Wang, Rauworth, & Jurkowski, 2004). Interestingly, our results indicate also the opposite way of this relationship, namely that physical activity, which is known to be influenced by SCT variables like outcome expectations, social support, barriers or self-efficacy (Anderson, Winett, & Wojcik, 2007; Anderson, Wojcik, Winett, & Williams, 2006; Plotnikoff, Costigan, Karunamuni, & Lubans, 2013), may be a mediator for HTU in older adults. By addressing the factors influencing physical activity engagement in older adults, HTU and their effectiveness in improving health in older adults may be increased.

7 Design implications

Based on our qualitative and quantitative studies presented in D 2.5 and D 2.14, we were able to derive eight implications, relevant for the design of My-AHA, (1) build trust, (2) improve comprehensibility, (3) raise awareness, (4) apply an individual persuasion strategy, (5) strengthen autonomy, (6) support individual socio-technical fit, (7) integrate the social environment and (8) ease access to physical activity and healthy behaviour.

Build trust: My-AHA should allow the user to familiarize with the approach of digital collection and storage of health data. Therefore, sensitive health data should not be requested early on, for instance during the registration process. Older adults should be allowed to try out the application and gain practical experiences in order to release fears and confirm its usefulness. Further, the visual appearance of the application needs to represent an appropriate degree of seriousness and reliability. This may be achieved by providing clear and logical structures, a consistent appearance and a synchronized color scheme. Finally, the application needs to provide sufficient information about the operator of the application and transparency about the procedures of data processing. According to our study, it seems though that older adults with high technology experience benefit most from information and transparency, while older adults with low technology experience benefit more from time and visual aspects mentioned in this section.

Improve comprehensibility: The graphical user interface should avoid scientific, medical or technical terms, as well as terms in foreign languages. Instead, the application may use terms related to the everyday language of older adults. In case specialized terms cannot be avoided, explanations appropriate for the target group have to be provided. For comparison and interpretation of individual health data, the use of individual health reference values may counteract false expectations or overexertion, induced by comparisons between individual health data and general reference values, derived from professionals or literature. Depending on the disease, general reference values may fail to serve as a reasonable and appropriate orientation. In this context, proactive system messages need to consider an adequate and sensitive wording, especially when measurements exceed the normal range, to prevent negative consequences on the emotional well-being of older adults. Further, proactive system messages should include suggestions or recommendations directly convertible into everyday life. In terms of health data and results presentation, visualizations need to be as simple as possible. The key message of a chart should be comprehensible at first sight.

Raise awareness: Illustrating health benefits by means of reasonable and transparent measures and effects of prevention may increase older adults' awareness with respect to active healthy ageing. Practical experiences seem to be key for older adults to perceive prevention activities as useful. Providing experience reports or recommendations of peers might help attract older adults' attention for prevention activities. Such functionalities therefore can constitute a valuable component in the design of MY-AHA.

Apply an individual persuasion strategy: Persuasive elements such as proactive feedback, goals or reminders should only be used by one's own choice. Allowing configuring these functionalities according to the users' preferences is crucial to address concerns and fears with respect to controllability. If support through persuasive elements is desired, proactive messages and goals need to behave in a context-sensitive manner, appropriate to measured values and user behavior.

Strengthen autonomy: A modular structure of prevention programs and alternatives for each health domain provides older adults with the autonomy to select preventive measures suitable for their individual life style, demands and interests. Further, the wording of proactive messages needs to address individual characteristics

and preferences of older adults to prevent feelings of patronization. Proactive messages should always follow a rationale that is comprehensible by older adults. Functionalities with respect to data transfer to other parties within the health eco-system should be transparent and their execution should remain in the hands of older adults at all time.

Support individual socio-technical fit: Self-assessment technologies, as well as integrated health platforms like MY-AHA will always collide with already existent practices of people. Thus, there are health-promoting activities, for instance swimming or dancing, which older adults integrated into their daily routines, long before health technologies entered the scene. Health technologies are not capable to monitor such activities reliably. To prevent frustration, easy and effortless alternatives for older adults to enter such data manually need to be provided by My-AHA.

Integrate the social environment: Social aspects in HTU are of utmost importance for older adults. Health technologies should embed their training programs in social contexts, for instance physical activities that end in socializing events like communal cooking or community cafes, where older adults can share their experiences, exchange information and connect with people of the same age or with similar interests. Health technologies should provide functionalities to bring older adults with same physical activity interests together.

Ease access to physical activity and healthy behaviour: Our studies show that the use of health technologies is not primarily determined by technological factors like ease of use, usability, user experience, etc. but by facilitating factors that ease the access to physical activity or healthy behaviour in general and further allow seamless integration into daily life routines. Therefore, My-AHA needs to emphasize on such factors and provide a platform for social interaction and integration in the context of a healthy behaviour to leverage sustainable impacts on older adults' health, induced and supported by a long-term application of My-AHA.

8 Conclusion

This deliverable provided an update on the end user requirements presented in D2.5. Main findings in this deliverable concerned with disparate perspectives of primary and secondary stakeholders, how these can be negotiated for the design of my-AHA and what factors may be relevant to predict health technology use. The results show that primary and secondary stakeholders have very different conceptions on independence and well-being. The design of my-AHA needs to negotiate such differences and address them in the system. Moreover, our study shows that trust is an important factor for the use and acceptance of health technologies. For instance, older adults put more trust in technologies that are recommended by their doctors. Therefore, my-AHA needs to underline its value for secondary stakeholders. We described how this could be realized, for instance by providing secondary stakeholders with functionalities to determine the quality of health information primary stakeholders consume. Our quantitative study showed that technological aspects seem to be of less importance for older adults, while factors influencing physical activity engagement matter more for them. Therefore, my-AHA needs to put at least the same emphasis on such factors affecting physical activity engagement in older adults to ensure continuous use of my-AHA. The design implications provided in this deliverable will help to address disparate perspectives of primary and secondary stakeholders and practices and attitudes of older adults in my-AHA in order to build a system appropriate for relevant stakeholders.

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