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Investigating the relevance of monitoring health domains using technology among older adults: health, technology and older adults

Nada El Menshawy

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Supervisors:

Dr. S. Kelders (Saskia)
M. Sc. M. Cabrita (Miriam)

Positive Psychology and Technology
Faculty of Behavioural, Management and Social sciences
University of Twente
P.O. Box 217
7500 AE Enschede
The Netherlands

Abstract

Introduction: Monitoring of health is becoming more important because the number of people receiving home care in the upcoming years will increase significantly and there are also more chronically ill older adults (World Health Organization, 2015). Many chronically ill people and older adults want to continue living in their own homes and in their own environment as long as possible. A way of monitoring health is the use of technology. The research aims are (1) evaluating the health domains that should be monitored from the perspective of older adults, (2) assessing the perceived usefulness and perceived ease of use of monitoring technology, and (3) investigating the acceptance of monitoring technology.

Methods: Twelve adults aged above 65 years were questioned during interviews and a case study for the health domain physical activity is employed, whereby the participants used monitoring technology (smartphone, smart scale, and pedometer) for a period of four weeks and were secondly interviewed.

Results: Most participants (N=8) would like to have an overview of their calorie intake, because of their health issues. Besides, it is important that nutrition monitoring takes specific needs into account. Participants would like to train their cognitive skills, but are not interested in having an overview of their cognitive function (N=9). All participants consider that it is important to train their cognitive function, because they are aware that it declines with time. Participants mentioned that they like to use technology to monitor their physical activity (N=11). The main perceived added-value of it is to get an overview of their daily physical activity and to see if whether they are meeting the recommended guidelines (N=9). Participants mentioned that it would be interesting to monitor wellbeing (N=5).

After using the technology, participants (N=11) mentioned that they like to use technology to monitor their physical activity, that they became more aware of their physical activity and that it is actually very handy and nice to have it (N=5), and that they became more active (N=8).

Conclusions: The domains nutrition, cognition and physical activity are important to monitor. Besides these domains, older adults mentioned wellbeing and physiological parameters at home (e.g. blood pressure and heart rate) important as well, but are less important. Older adults are aware that it is important to have insight in all of these health domains.

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1. Introduction

According to the United Nations (2013) Europe is the world region with the highest proportion of older adults and it is predicted to remain this way until 2050 (United Nations, Department of Economic and Social Affairs, 2013). This means that healthcare in Europe has in the near future a large number of challenges. The world population is getting older but the extra years are often not healthy years. Older people often have to deal with at least one chronic disease (World Health Organization, 2015). The number of people receiving home care in the upcoming years will increase significantly and there are also more chronically ill older adults. Many chronically ill people and older adults want to continue living in their own homes and in their own environment as long as possible (Zantinge, van der Wilk, van Wieren, & Schoemaker, 2009).

Preventive care could be an outcome to maintain living independently. The goal of prevention aimed at older adults is to ensure that older adults stay as long as possible autonomous, independent, and healthy. To achieve this, prevention can be focused on the physical, social and on the mental domain. Healthy and successful aging is not just about preventing and delaying disease and mortality, but also to the prevention and delay of the functioning of disability, the prevention of loss of self-reliance and reducing dependence on healthcare (Zantinge et al., 2009).

Furthermore, when getting older, the perception of being healthier changes from being free of illness to being able to perform the daily activities independently (Zantinge et al., 2009). This ability, is restricted by the physical and cognitive function of the older adults. Physical limitations are limitations in hearing, vision, mobility. Cognitive limitations are limitations in perception, language, memory and / or thinking. The increasing functional limitations of aging affect the ability of older adults to perform activities of daily functioning (Pol et al., 2013).

Two categories of daily functioning are important factors of their ability to live autonomous, independent, and healthy. In order to live independently at home as an older adult, the maintenance of activities of daily living is very important. These called Activities of Daily Living (ADL), include activities such as sitting down and getting up from a chair, climbing stairs, getting in and out of bed and standing (Zantinge et al., 2009). Other activities referred to as ADL are e.g. walking, eating, toileting, grooming, sitting, walking, lying and standing.

Furthermore, Instrumental Activities of Daily Living (IADLs) are more complex actions which are more cognitive demanding and often refer to the participation of the individual in the society, e.g. shopping, managing medications, handling money, problem-solving and doing housework (Cabrita et al., 2015; Pol et al., 2013).

Several areas are important in maintaining ADLs and IADLs. Physical activity is related to the ADLs, a physically active lifestyle is crucial for prevention of chronic illnesses and for the general health and wellbeing of the older adults population (Cabrita et al., 2015). Furthermore, according to Sánchez-Martínez et al. (2016), poor physical activity is strongly associated with disability, nursing home admission, poor health and quality of life and short-term mortality. Nutrition is important because it contributes to the functional ability and health. Moreover, the nutritional state has an high impact on physical and psychological wellbeing in the older adults and older adults people are in higher risk for nutritional deficiency (Pirlich & Lochs, 2001). Furthermore, cognitive functions like attention, memory and executive functions have been considered as having the highest influence on activities of daily living. In order to maintain independently living, continue carrying out ADLs, and to be able to intervene when necessary, it is important to monitor the physical activity, nutrition and cognition of older adults.

Monitoring of health is becoming more important and it is important to get to know more about monitoring of health. A way of monitoring health is the use of technology. Since the late 1980s interest in technology and aging research is continuing to grow worldwide (Schulz et al., 2015). Furthermore, use of ICT in health care is essential to improve the functional ability of future generations (World Health Organization, 2015). Currently there is a large variety of monitoring devices available in the healthcare area, including wearable sensors that are able to measure physical activity, heart rate, blood pressure, and temperature. But also freestanding devices exist that can measure various physiological criteria, such as wound healing and blood oxygen (Schulz et al., 2015). All these systems can be used to inform people about their health status. It allows the users to detect changes on different domains and it may motivate to address the problem. Despite the large number of technologies currently available in the market aiming to promote healthy lifestyles, these often target the young and healthy consumer leaving a lack of solutions targeting the older population. Most of these technologies, e.g. wearable sensors, are accessible for all people (Verdezoto & Grönvall, 2016). An example of a wearable sensor is the Fitbit Zip™, this wearable sensor measures, among others, the physical activity by translating the movement of the user into steps.

This thesis will evaluate which health domains and parameters (Table 1) are relevant to monitor from the perspective of the older adults. The first domain is physical activity. The second domain of which the relevance will be evaluated is nutrition. Parameters such as height, weight and Body Mass Index (BMI) are included within nutrition domain. As third domain, the need for monitoring the cognitive functions will be evaluated. Besides the domains physical activity, nutrition and cognition, it will be researched whether there are other domains that are relevant to monitor, from the perspective of the older population. It is important to take the perspective of the older adults into account, for instance research of Paap, Bode, Lenferink, Terwee, and Van Der Palen (2014) shows that the perspective of the users should play an important role in domain selection by developing a tool.

Table 1. *Selected domains and parameters*

Domain	Physical activity	Nutrition	Cognition
Parameters	Amount of steps	Height	Memory
	Amount of active minutes	Weight BMI	Attention/Concentration

Technology acceptance model

Hence there is a potential for technology to be used to monitor the daily functioning of older adults and to overcome the mentioned challenges of aging in healthcare. Despite the great possibilities of technology, the expansion of technology in healthcare among older adults remains difficult (Currie, Philip, & Roberts, 2015). To improve our understanding of older adults' attitude towards accepting and using technology, a lot of technology acceptance research has been done. The technology Acceptance Model (TAM) is a model that explains how it comes that users accept a new technology and start using it, see Figure 1 (Davis, Bagozzi, & Warshaw, 1989). The model shows that, when users get presented a new technology, such as an application for the smartphone, there are a number of determinants which influence how and when they will use the technology. The key components of this model are the Perceived Usefulness (PU) and the Perceived Ease of Use (PEOU). According to a systematic review of Peek et al. (2014) these two components explain forty percent of the intention to use a technology in several context including healthcare. This model also assumes that the intention could predict to the actual use of technology. Studies outside and within the consumer health informatics discipline have consistently found that perceived usefulness of a technology is

associated with the acceptance of the technology (Or et al., 2011). This suggests that users will be more likely to accept the technology if they believe that the technology is useful as it can convey health benefits or facilitate self-management. The TAM will be used in this research to get insight in the acceptance of health monitoring technology by the older adults. To learn more about the perceived usefulness and intention to use there will be interviews conducted.

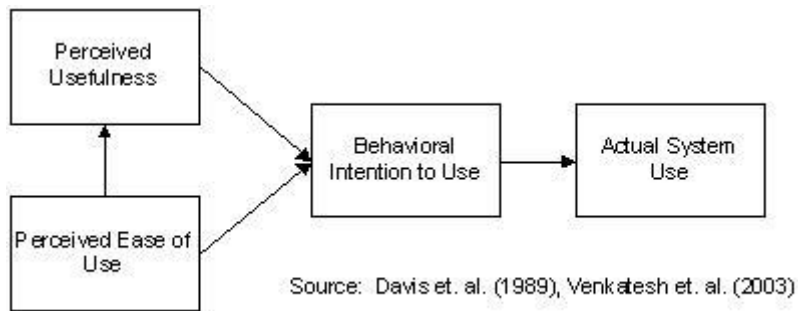


Figure 1. *Technology Acceptance Model (Davis, Bagozzi & Warshaw, 1989)*

Research aims

1. To evaluate the health domains that should be monitored from the perspective of older adults.
2. To assess perceived usefulness and perceived ease of use of monitoring technology.
3. To investigate acceptance of monitoring technology.

2. Methods

Context of the study

This research has been done in collaboration with a bachelor psychology student and a PhD candidate of the University of Twente whereby this thesis takes part in two studies in the bigger European PERSSILAA¹ project on monitoring health of older adults. The two bachelor thesis studies will be done in collaboration and parallel with each other.

Design

A semi-structured interview design and case study is employed.

Participants

The participants were recruited by asking participants of the PERSSILAA-project if they wanted to participate in this study. The requirements for participating was that they have to be older than sixty years. There were 23 people informed, whereby finally 12 of them participated and one of these twelve only participated in the first phase of the study. Participants in the study were informed during information markets of the PERSSILAA-project (N=5), they were already participating the PERSSILAA-project (N=5) or were acquaintances of former participants in the study (N=2).

Procedure

Ethical approval was requested and received from the University of Twente. After the participant accepted to participate in the study, they received an information letter which can be found in Appendix A whereby the participant is invited to a first interview with the researcher. This is been done by phone or email. There were two sessions with the participant, whereby in the first session the participant got an explanation of the research and the first interview took place. The second session was about the experience with the technologies. In between the two sessions, which is a period of approximately four weeks, the participants were using the technology in their home situation (Figure 2).

¹ www.perssilaa.eu



Figure 2. *Timeline of the study*

First interview

In the first interview it is emphasized that their opinion and attitudes are important and that the participant has an active role in the development of a mobile application that will be used in a number of target groups for the monitoring of physical activity and that we want to understand what the needs of the participants are to meet these needs with such a mobile application. In the beginning of the first session all participants signed the informed consent (Appendix B). Moreover, the first session took approximately one-and-a-half hours whereby some questions and an explanation were given of the technology that will be used for a period of four weeks. The notes that have been used for explaining the technology can be found in Appendix C. The interviews were audio recorded.

Four weeks in between

After the first interview the participants got the technology on loan to use the technology for a period of four weeks. The participants were able to contact the researchers indirectly by email, phone, and TeamViewer. And it was also possible contact the researchers directly in the Roessingh Research and Development building to solve any technical issues face-to-face.

For other research purposes the participants also answered on the phone every day a short questionnaire around 20.30h regarding their experience of positive emotions during that day. An example question is: "Please indicate to what extent you have experienced these emotions today: happy, delighted." This took no more than 30 seconds.

Second interview

After using the technology the participants were invited for a second and last interview. The experience with the technology were asked and what their attitude towards monitoring health using technology was after experience the technology by themselves.

Materials

First interview

An interview scheme is designed which can be found in Appendix D (the English version can be found in Appendix E). The interview began with the exploration of the interview and introduction. In this introduction it was mentioned that the interview will be audio recorded and the participant was asked to give permission for this and sign the informed consent. The interview consists of six main topics, namely general health status, nutrition, cognition, physical activity, other parameters and technology use. The general health status questions serve the purpose to create a context to go further with the other topics by opening the interview and talk about their general health. For example the participant was asked what he/she does to stay healthy.

The nutrition, cognition and physical activity topics have the same structure, namely an introduction question, importance of monitoring, use of technology for monitoring, and the intention to use the technology. The intention to use is subdivided in the needs, aim and consequences. The type of questions for each subtopic can be found in Table 2. The topic of other parameters was structured by openly questioning if there are any other parameters, this was to not influence the answer of the participants. When wellbeing or mental state were not mentioned, this was asked and the same structure of the earlier asked parameter questions were followed.

Table 2: *Subscales parameters questions*

Subtopics	Question example ‘cognition’
1. Introduction question	What are you doing to keep track of your cognitive skills? (If necessary give examples like sudoku, puzzles or memory games)
2. Importance of monitoring	Do you find it relevant to monitor your cognition?
3. Using technology	What is your attitude towards the use of a website or mobile application to keep track of your cognition?
4. Intention	

<i>Intention to use</i>	Would you use such a website or mobile application on a daily basis?
<i>Needs</i>	What would you like to see or track? / What are your needs?
<i>Aim</i>	It is sufficient to see it alone, or do you also want feedback / tips / guidance? So what is the purpose of tracking this information and how do you achieve that goal?
<i>Consequences</i>	What would you do with this information? Further: Would you like to see it alone or do you share it?

To get a general impression of the technology use of the participants there are three technology use questions whereby the technology self-efficacy (*I am able to use my mobile phone.*) and technology anxiety (*I think I would never completely understand a mobile phone.*) questions are scaled on a five-point Likert-scale which goes from strongly disagree to strongly agree. The technology current-use question (*What do you use your mobile phone for?*) is categorized in calling, messaging, WhatsApping, emailing, using apps, and other. To get information about the general background of the participants a short questionnaire for demographics were given to the participants. In this questionnaire age, gender, living situation and educational background were assessed.

Use of technology

For the case study for the health domain physical activity the participants receive an activity sensor (FitBit Zip), a smartphone (Samsung Galaxy Neo 3) and a smart scale (Withings Smart Scale WS-30) on loan for a period of 4 weeks. The FitBit Zip is small and can be carried in the pocket and records the amount of daily movements. The phone has a mobile application, named Activity Coach, where the actual physical activity, how far it is from his or her goal and the activity of today and the last seven days is shown. Additionally, participants may use the smart scale which is automatically connected with the smartphone.



Figure 3. Devices used to research the acceptance of technology monitoring physical activity

Second interview

There is a second session whereby, for other research purposes, the usability and experiences with these technologies were assessed. In this interview the attitude towards using technology by monitoring health was evaluated (question 12). The interview scheme for this second session can be found in its original version in Appendix F (the English version can be found in Appendix G).

Data analysis

The questions about technology use (self-efficacy, anxiety and current use) were quantitatively analyzed by using the data management program SPSS. The remaining questions were qualitatively analyzed by transcribing the interviews and recoding into overarching categories/codes. The structure of the interview scheme is used to design the code scheme (Appendix H). The analysis of the qualitative data has been done with the qualitative data analysis and research software ATLAS.ti. The unit of analysis was a meaningful unit of an answer. The unit may vary in length, when a participant told in a few answers about the same code, it is coded as the same code and not separately.

3. Results

There were seven females and five males participating in the study, whereby the mean age of the participants was 69 (65-78). Other demographics of the participants, which are gathered using a short questionnaire, can be found in Table 3.

Table 3. *Demographics participants*

Characteristic	
Age (mean, range)	69, 65 - 78
Gender	
Female	7 (58%)
Male	5 (42%)
Living Situation	
Alone	3 (25%)
With someone else	8 (67%)
Missing	1 (8%)
Education	
Elementary School	1 (8%)
High School	3 (25%)
Vocational School	6 (50%)
University	1 (8%)
Missing	1 (8%)
Smartphone	
Yes	8 (67%)
No	4 (33%)

Technology use

Eight participants have a smartphone, whereby five participants are advanced users of the smartphone, which means that they do not use their phone only for calling and messaging, but also searching on the web, WhatsApp and email. Moreover, eight participants think that they will never understand a mobile phone/smartphone completely. On the 5-point Likert scale (1. strongly disagree, 2. disagree, 3. neither agree nor disagree, 4. agree, 5. strongly agree) the mean of the technology self-efficacy statement (*I am able to use my mobile phone.*) is 3.50 ($SD=1.09$) and of the technology anxiety statement (*I think I would never completely understand a mobile phone.*) is 3.42 ($SD=.90$). A detailed outcomes table of the technology

use can be found in Appendix I. Two female participants showed privacy concerns regarding the data acquired from technology. This was also one of the reasons for dropping out for one of these participants.

Nutrition

Perceived Usefulness

Most participants are conscious about their daily food intake and they are aware about the importance of a healthy diet. Most participants (N=8) would like to have an overview of their calorie intake, because of their health issues. Besides, it is important that nutrition monitoring takes specific needs into account (N=9), for example, for participants suffering from diabetes it is interesting and may useful for them to see some feedback about their food intake if they eat too much sugar (N=5). For a participant with COPD and participants who are overweight and have to be careful with their weight, it is important to know when they eat too much fat and they would like to get some information about food. So for them it is not only important to know the amount of fat and calories, but also information about the types of fat in food (N=4). In general, participants showed interest in following recommendations that would help them to adopt a healthier diet. Four participants mentioned that they want to see healthy recipes in an application or website. If a phone application or website is monitoring their food intake, they would also like to get help to have a healthy diet, therefore they want to see healthy recipes which can help to cook healthy and at the end it could be monitored what the food intake is. This quote illustrates the abovementioned:

Ik wil eigenlijk informatie over wat ik nu eigenlijk mag hebben, maar ook dat het bijhoudt wat ik zelf binnenkrijg uiteindelijk, dat het gepersonaliseerd is op mij en niet alleen gekeken naar het gemiddelde van mijn leeftijd maar wat ik zelf echt nodig heb.(user16)

Monitoring weight is important an important parameter for participants (N=10), especially for the participants which have to be cautious concerning their health issues (e.g. diabetes, COPD, overweight and obesity). Two of these participants do find it important to monitor their BMI.

Table 4. *Nutrition: Perceived Usefulness*

Perceived usefulness	N
Calorie intake	8

Taking specific needs into account	9
Recommendations	4
Weight	10

Intention to Use

There were 9 participants who want to monitor their nutrition with the use of technology. The reasons for the 3 participants who do not want to monitor nutrition with the use of technology were on the one side that they are already aware enough that they have a healthy diet routine (N=1) and they would not change and on the other hand that they do not want to use technology (N=2) but would rather talk with a someone (a specialist) about it.

Het is misschien wel leuk als je hoort van je doet het goed, misschien wel, maar dan heb ik dat liever een-op-een, dat je ergens naar toe gaat, maar niet met computers. (...) Telefoon eventueel, als ze me bellen of als ik hun kan bellen.. ja weet je wat het ook is, ik wil me niet aan alles en nog wat vastbinden. Dus aan de ene kant ben ik daar twijfelachtig over, van ja dat is misschien wel wat en aan de andere kant denk ik van ja moet dat. (user06)

Cognition

Perceived Usefulness

Participants would like to train their cognitive skills, but are not interested in having an overview of their cognitive function (N=9). All participants consider that it is important to train their cognitive function, because they are aware that it declines with time. And it is not that much important how this training will be, this quotation illustrates this:

Ik vind wel dat je het op een één of andere manier moet trainen en of dat middels puzzels moet of middels een appje of middels eh het zal mij een zorg zijn, maar het moet wel gebeuren. (user11)

On the other hand participants reported that they are afraid to get to know if their status is below average or getting lower. Participants would like to be able to play cognition games (e.g. memory games) on an application, and that they can see some statistical results. These games are seen as a training for their memory status, because when the participants talk about their cognition status, they think about the memory beyond other cognition parameters. One

participant mentioned that it would be nice to have games with levels of difficulty so that it is comprehensible and it gives the feeling that he/she achieves a higher level. The cautious attitude towards knowing the status of the cognitive function appears in this quote:

Oh, daar ben ik gewoon bang voor, weetje dat? het toch is gebleken, dat bij diabeten dementie veel vaker voorkomt en dat verstop ik gewoon. Ik zeg het nu aan jullie, maar ja dat is toch wel een angst die ik bij mij draag. Ja, dat is best wel moeilijk, omdat ik daar toch bang voor ben. Dat is toch een angst die ik bij mij draag. (user05)

One participant who already joins the PERSSILAA project, where there is already a cognitive training part, mentioned that it *would not be wrong* if the cognitive training games that are in the project, will be available in a phone application because it is easier accessible than the computer.

Dat zou niet verkeerd zijn, dan zijn ze beter toegankelijk en ben je niet afhankelijk van de computer als die het niet doet. (user11)

Table 5. *Cognition: Perceived Usefulness and Intention to Use*

Perceived usefulness	Intention to use
Training games (N=11)	No comparison with the average (N=9)
Phone instead of computer (N=3)	Phone application is easier accessible than computer (N=1)
Not interested in an overview (N=9)	

Intention to use

The participants are not comfortable with seeing results which compares their results with the average. If it is only a training, what they found interesting and understand to play, they would like to use it. Another point of intention to use was that a phone application is easier accessible than a computer.

Physical activity

Perceived Usefulness

What has come forward during the interviews is that the main perceived added-value of monitoring the physical activity is to get an overview of their daily physical activity and to see if whether they are meeting the recommended guidelines (N=9). The motivation to be physically active is to continue doing the things they are used to do. Five participants mentioned explicitly that they feel happier when they are physically active. Moreover, the participants were all aware that physical activity is very important for being/staying healthy and showed to be afraid of stopping being active. Therefore all the participants are interested in having insights in their physical activity, nine of the participants would like to use technology by monitoring their physical activity.

The participants were interested in having an overview of their activity to compare days, weeks and months with each other to get more insight if they are enough physically active (N=10). Duration of physical activity (N=5), amount of steps (N=11), walked or cycled distance (N=10) are parameters that is mentioned by the participants. Because the concept of monitoring health by using technology is not a common concept within the participants, in most interviews examples were given and after these examples these parameters were mentioned. Four participants mentioned that they would like to have daily feedback next to these overviews. This feedback could be positive announcement or pop up (e.g. 'Great job!') or when the user is not active enough e.g. 'Take a walk!'. Besides these parameters, one participant with back problems would like to have exercises in an application with explanation of the power level of each exercise. (...*de ene keer lukken oefeningen beter lichamelijk dan de andere keren en wat dan de reden is waarom dat wel of niet zo is.* (user16)) Some participants (N=4) would like to share their accomplishments with friends or relatives; others would not like to have this functionality. Some participants (N=3) that would not share it with others and just keep it for themselves mentioned that they would anyway want to share it with their specialist (e.g. physiotherapist).

Participants mentioned that they want to use an application which monitors their physical activity if there are some exercises in which you feel satisfaction when achieving these exercises. According to two participants this could be done by using a points system, whereby there are exercises in which points can be earned with. One participant mentioned that this

could also be done with plusses and minuses. A remarkable comment of a participants about this was: *‘Dat er toch iets in zit wat eh, mensen willen gewaardeerd worden hè, ook door een computer.’* (user11). So it is important for the older adult to be appreciated, even by a computer.

Table 6. *Physical activity: perceived usefulness and intention to use*

Perceived usefulness	N
Meeting the recommended guidelines	9
Important for being/staying healthy	11
Day/week/month overview	10
Daily feedback next to these overviews	4
Feeling happier when physically active	5
Exercises	2
Share achievements with others	4

Intention to use

Participants find it important to monitor their physical activity and will use technology to monitor it when the options that are perceived as useful are included in this technology. A point system would motivate them to use it and when they get some satisfaction from using it, they would use it.

Other domains

Participants (N=3) showed interest in being able to monitor physiological parameters at home (e.g. blood pressure and heart rate). Mental health was mentioned by some of the participants (N=2) in terms of how they feel inside and not only physically. After asking if wellbeing should be monitored, five participants mentioned that it would be interesting, reasons were that they would be more aware of it and may see an overview of their mood over the week or month. Two participants mentioned that they would relate it to their physical activity, in order to see if they feel really happier or better when they are more physically active.

Ja, dat is ook wel makkelijk als je dat terug kunt slaan. Dan en dan was ik niet zo lekker, toen heb ik dat gedaan. Nu ben ik wel goed te pas en nu doe ik dit, nu kan ik zoveel. Dat is wel makkelijk denk ik dat je dat kunt zien. (user07)

Six participants think it would be useless to monitor wellbeing, because it is too personal information and do not see the usefulness of doing it. Especially the participants who already are concerned about the safety and confidentiality of their information by the use of technology were not interested to monitor their wellbeing.

Acceptance of technology (physical activity)

Perceived Ease of Use

In the second interview, after using the technology, most of the participants (N=11) mentioned that they like to use technology to monitor their physical activity. Another result is that 8 participants mentioned that they became more active because of the given overviews of amount of steps a day and a week (*...dat vind ik wel heel leuk. Het stimuleert je gewoon en ik vind het wel leuk om bij te houden wat je doet en wat je per week doet en per dag (user19)*) Of the 6 participants who mentioned in the first interview that they are not active enough and who are not enthusiastic about the use of technology, 5 mentioned in the second interview that they became more aware of their physical activity and that it is actually very handy and nice to have it. *Ik vind het een kunststuk in feite, dat dat zo kan (...) Omdat het toch wel je bewust maakt van dingen, waar je niet zo maar bij stil staat. Bijvoorbeeld dat met het bewegen, dat heb ik eigenlijk nooit zo bekeken, dat het s 'morgens gewoon niet bij mij telt. Dan zie je het pas...(user18)*

4. Discussion

The first aim of this research was to evaluate the health domains that have to be monitored from the perspective of older adults. The second aim was to assess perceived usefulness and perceived ease of use of monitoring technology. Finally the acceptance of monitoring technology has been investigated. First the main findings of the investigation will be discussed. The second part shall focus on the implications for further research. On this basis, limitations will be discussed and the discussion section will conclude with a final remark.

Main findings

Nutrition

Within the nutrition domain, all older adults found it important to have insight in their diet. It is especially important to monitor, because of the specific needs of the older adults.

Respectively, older adults often deal with at least one chronic disease whereby there are several health issues that have to be taken into account in their daily living (World Health Organization, 2015; Zantinge et al., 2009). This is the case with older adults who have to be cautious with the intake amount of different kinds of fat, sugars and calories. Concluded for the nutrition domain, from the perspective of older adults it is important to monitor the amount of calories, sugar, sorts of fat. This information is been used to have a healthy diet.

With use of technology, older adults would like to see healthy recipes and information about nutrition. It is hereby important to have information why some kinds of food are healthy.

About the perceived usefulness it can be concluded that older adults find it useful to monitor nutrition when it shows them an overview, which allows them to get insight in their diet.

Getting insight in their food intake makes it possible to be aware of how healthy they are eating and drinking, and can be fit to their health issues (e.g. eating less sugar in case of diabetes). According to a review study of nutrition interventions, a lot of interventions are already trying to do this (Hoelscher, Evans, Parcel, & Kelder, 2002).

Cognition

The opinions about monitoring the cognitive function are more divided. Older adults are aware that their cognitive function is decreasing in time, but are uncomfortable with monitoring it. This is in accordance with research of the Institute for Aging Research in which only one third of the older adults were interested in cognitive training (Howard, Rosenberg, Rockett, & Morris, 2012). In this research of Howard et al. (2012) it is not clear if the

participants were only interested in a cognitive training in form of a game, or whether they are also interested in seeing their cognitive status. There is so far no research found in with is investigated if older adults are interested in seeing and monitoring their cognitive function status. It makes it more complex to monitor, because older adults do not prefer to get an insight in how their cognitive status is in comparison with the average, e.g. with the average of their age. They are familiar with the consequences of this decreasing functions, because people in their environment suffer from dementia or Alzheimer. But also they experience the cognitive impairments in their activities of daily living, e.g. forgetting and difficulty in concentrating. It can be said that monitoring cognition could be seen as a cognition training, because older adults are interested in improve their cognitive status. Furthermore, using technology (i.e. computers and/or smartphones) to train cognitive function is in accordance with McCallum (2012), because computer games may be able to contribute to delaying cognitive degradation.

As follows older adults are not interested in feedback in which their cognitive function are compared with the average, it is an open question for further research how it could be than monitored and implemented in such an monitor tool wherein the needs of the older adults are met. A suggestion to monitor cognition could be to give feedback after a cognition training game and compare this with recent results, and not with results from for example maximum one year. In this way the older adults will not see the high amount of decreasing when this is the case. An option could be that the results, including results older than one year, are available for healthcare specialist of the older adults. In this way the cognitive function is monitored in such a way that it could meet the needs of the users.

Physical activity

Besides, for the physical activity domain it can be concluded that older adults highly value if they are physically active enough and if they meet the recommended guidelines. Moreover, physical activity is important to maintain for older adults in order to prevent disablement and disease which is in accordance with Nelson, Rejeski, Blair, Duncan, and Judge (2007). It is therefore a positive finding that older adults would like to have an overview of physical activity. Older adults are aware that a physically active lifestyle is an important factor to stay fit and being healthy, indeed they are afraid of stopping being active and are interested in technology that could help them to be or stay physically active. Parameters which has to be monitored, from the perspective of older adults, are duration of physical activity, amount of

steps, and walked or cycled distance. These parameters are already in available monitoring devices (McGrath & Scanail, 2013). This information could be used to compare overviews of days, weeks or months with each other in order to improve the physical activity behavior. Other content that they think would be useful are some exercises in a mobile application in which points could be earned, whereby a points system could motivating them to do these exercises. Using such a points system is called ‘gamification’, whereby studies point out the effectiveness of it (Gotsis, Wang, Spruijt-Metz, Jordan-Marsh, & Valente, 2013). As a study showed, a phone application which support physical activity which provides feedback to the user can significantly increase and maintain the level of physical activity in healthy older adults (Hurling et al., 2007).

Other domains: Wellbeing

Furthermore, older adults finds the three health domains, nutrition, cognition and physical activity the most important domains that has to be monitored. This finding is in accordance with the literature (Pirlich & Lochs, 2001; Pol et al., 2013; Sánchez-Martínez et al., 2016). However, wellbeing is a domain that is an important factor which influences their health status, because from the perspective of the older adults it is important to not only feeling physically good, but also feeling mentally or psychologically good. The latter can be seen as wellbeing. Yet, older adults did not mention this view in first respect, but after asking the role of wellbeing in their health status. The finding that wellbeing or mental health is scarcely mentioned is in accordance with for instance in research of Paap, Bode, Lenferink, Terwee, and Van Der Palen (2014), because physical health and social health was seen as important overarching themes among older adults, while domains associated with mental health were scarcely mentioned. One explanation for this finding could be that the older adults finds it too personal to give information away about their personal status of wellbeing, or their own thoughts about their feelings. This is also mentioned by one participant during this research. Older adults are aware that their wellbeing could be important for their overall health status, but they were living in the present and a big part of the participants were not interested in monitoring their wellbeing, because they find it important to live every day at the time and appreciate each day. This is in accordance with Borglin, Edberg and Rahm (2005) in which this was also found. It could be useful to train wellbeing instead of monitoring it. There are several mini exercises within the positive psychology, which could be included in an phone application or website (Schueller & Parks, 2012). An example of such mini exercise is that the older adults are asked to reflect each day on three good things that happened by writing this

down (Schueller & Parks, 2012). This way the older adults are not monitoring, but work on improvement of their wellbeing. However, this does not mean that it is completely useless to monitor the wellbeing of older adults. Good psychological health, which includes positive affect, is increasingly recognized as having protective benefits against poor health issues (Fredrickson, 2003). It is indeed that there is evidence from a lot of epidemiological studies that show that positive affect has the potential to decline the risk of acute medical events (Ostir, Ottenbacher, & Markides, 2004).

Intention to Use & Acceptance of Technology

For all the health domains the intention to use is that if the technology allows the older adults to improve their status of the health domain, than they report that they would use it. The two elements of the Technology Acceptance Model of Davis (1989) become here apparent, namely the perceived usefulness and the intention to use. The older adults are intended to use a monitoring tool and accept technology, when they have a high perceived usefulness. Conditions are that it has to be easy to understand and that such technologies includes clear overviews. Currently many technology tools are insufficient when it comes to essential futures for some older adults, such as low memory-load interactions, easy-to-use menus, adequate help signals, etc. (Selwyn et al., 2003).

After using the monitoring technology for physical activity, older adults became more aware of their physical activity. The attitude of the older adults who were not familiar with technology and were not impressed of the possibility to use technology changed in a positive way, namely that it is useful to have such a tool that can help with being physically active.

Recommendations

According to Codagnone (2009) preventive health care has been less researched than disease management. Therefore there is less known about preventive care within this context. This research contributed to the expansion of research in preventive health care. It is recommended to monitor the health domains nutrition, cognition and physical activity. Wellbeing could be included, but is less important than these three domains from the perspective of the older adults.

In terms of usefulness of monitoring technology for nutrition it is recommended to have daily, weekly, monthly overviews of food intake and to personalize the functions to the older adults

(e.g. information about different sort of fats or sugary nutrition). For monitoring physical activity it is recommended to include duration of physical activity, amount of steps, and walked or cycled distance. In case of monitoring cognition, it is recommended to train cognition and putting effort in not showing it like a monitoring tool, but as a playful training. This could be done by including games within a web platform or mobile application with different levels which increases in difficulty. Older adults are interested in statistical results of their performance. An important factor hereby is not to provide a comparison with the average cognition status of the same age for example, because older adults are afraid of decreasing cognitive status.

Moreover, technology that are developed to use in daily life should target the individual needs and wishes of the users. Older adults want to have control over what is monitored and wish to manage whether data can be shared with friends and/or family, or health specialists. Finally, older adults find it, in addition to monitor health, important to have information about health and healthy behaviors. In terms of ease of use it is recommended to develop technologies that are easily accessible for the older adults. Older adults like to keep it simple and not too complicated functions, it is therefore important that an eventual technology application, e.g. a website or mobile application, is easy to understand. A suggestion is to expand the ActivityCoach application with the other health domains.

Limitations

One of the limitations of this research is that it does not take the perspective of health professionals into account, but only the older adults. The needs and perspectives of the healthcare professionals are also playing a crucial role, but because of the feasibility of this thesis the focus was on the users. Furthermore, within the PERSSILAA project, the opinion of the experts and health professionals are already taken into account while developing monitoring tools for older adults (Cabrita et al., 2015). The needs and perspectives of the health professionals are important because they are among the users of the monitoring technologies, namely the older adults. This means that the health professionals have a high influence on the success of these technologies. They have high competence and capacity to understand the use of technology rapidly, which differs from the actual users, namely the older adults (Chau & Hu, 2002). It is suggested for a future study to evaluate, with a similar design of this study, the relevance of monitoring the health domains from the perspective of health professionals.

Older adults found it difficult to think of something that should be in an phone application, without being informed about possible examples. This could also be seen as a limitation, because the older adults could have been influenced by the given examples, which could have a negative impact on the reliability and validity of the research. However, it was needed to give some examples to the older adults, because they were not familiar with the whole concept.

Another limitation is that there were several technological issues during the use of the technology in the period of four weeks, which had an influence on the attitude of the older adults. Some issues were that the FitBit was unexpected unpaired with the smartphone, the smart scale did not connect to the smartphone, the ActivityCoach application did not synchronize the data with the smartphone. All these issues made it impossible to show the data on the ActivityCoach application. Because of these technological issues the technology did not function what it was expected to function. This was especially a limitation by the participants who did not have a smartphone or are not impressed by the concept of monitoring health using technology. Because they already did not found it useful to use technology for monitoring their health status, the constraints of the technology did not work in favor of this study. However, there were participants which were positive towards the use of the technology. This could be explained by the fact that the participants were supported every time. When there were several technological issues, the researcher was available for the participants to contact and solve these problems.

Final remark

It can be concluded that, from the perspective of the older adults, the domains nutrition, cognition and physical activity are important to monitor. Besides these domains, older adults mention that wellbeing and physiological parameters at home (e.g. blood pressure and heart rate) are important as well, but are less important. Wellbeing in terms of feeling good and how the day emotionally is experienced. Older adults are aware that it is important to have insight in all of these health domains. This research contributed to deepen the knowledge about the needs of the older adults and their perceived usefulness and intention to use of monitoring technologies. It is up to further research to get more insight in possible implementations of monitoring these health domains taken these needs into account.

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Appendix A: Information letter

Titel onderzoek:

Gezondheid monitoren in het dagelijks leven met gebruik van technologie

➤ Informatiebrief voor deelnemers

Enschede, 8 maart 2016

Geachte deelnemer,

U hebt interesse getoond in het deelnemen aan het onderzoek “Gezondheid monitoren in het dagelijks leven met gebruik van technologie”.

Doel en achtergrond van het onderzoek

Gezond ouder wordt hangt niet alleen af van een goede gezondheid. Zowel fysiek als mentaal welbevinden hebben een grote impact op de kwaliteit van leven. Het is belangrijk dat u actief bent, niet alleen door bijv. fitness, maar ook door alle (kleine) bewegingen in het dagelijkse leven.

Dit onderzoek heeft drie doelen. Ten eerste willen we de relatie tussen fysieke activiteit en positieve emoties (bijv. gelukkig of ontspannen) in het dagelijkse leven analyseren. Ten tweede willen we graag uw hulp om onze mobiele applicatie te verbeteren. U heeft dan een actieve rol in de ontwikkeling van een mobiele applicatie die zal worden gebruikt bij verscheidene doelgroepen voor het monitoren van fysieke activiteit. Ten derde willen we inzicht krijgen in wat voor u belangrijk is om uw gezondheid te monitoren middels een mobiele applicatie. Dit maakt het mogelijk om technologische applicaties te laten voldoen aan de behoeften van de doelgroepen.

Het onderzoek

Eerst wordt u uitgenodigd voor een interview met de onderzoeker, voor uitleg van het onderzoek en over uw algemene gezondheid en actueel gebruik van technologie. Vervolgens krijgt u van de onderzoeker een activiteitsensor, een smartphone en een weegschaal in bruikleen voor een periode van 4 weken. Deze sensor is klein en kunt u in uw broekzak meenemen en registreert uw hoeveelheid dagelijkse bewegingen; de sensor meet niet wát u aan het doen bent. De telefoon heeft een mobiele applicatie waar u uw actuele fysieke activiteit kunt zien, hoe ver u bent van uw doel en de activiteit van vandaag en laatste zeven dagen. Ook beantwoordt u op de telefoon elke dag rond 20.30u een korte vragenlijst. Er wordt gevraagd over uw positieve emoties tijdens die dag. Een voorbeeldvraag is: “Geef hieronder aan in welke mate je vandaag de volgende emoties hebt ervaren: gelukkig, blij”. Dit neemt per keer niet meer dan 30 seconden in beslag. Daarnaast kunt u een weegschaal gebruiken die automatisch verbinding met de telefoon heeft. Daar kunt u ook uw gewicht zien van de afgelopen maand. Aan het einde van het onderzoek, hebben we opnieuw een gesprek, waarin uw ervaring met de mobiele applicatie wordt gevraagd.

Appendix B: Informed Consent

Toestemmingsverklaring

Titel van het onderzoek:

Gezondheid monitoren in het dagelijks leven met gebruik van technologie

Ik verklaar dat ik de informatiebrief heb ontvangen en gelezen en naar tevredenheid over het wetenschappelijk onderzoek geïnformeerd ben. Ik heb voldoende tijd gehad om over mijn deelname na te denken en ben in de gelegenheid geweest om vragen te stellen. Deze vragen zijn naar tevredenheid beantwoord. Mijn deelname aan het onderzoek is vrijwillig en ik ben gedurende het gehele onderzoek in de mogelijkheid om op elk moment te stoppen, zonder opgaaf van reden. Mijn verzamelde gegevens worden gebruikt voor het beschreven doeleinde van het onderzoek en zullen met zorg aankomende tien jaar worden opgeslagen volgens de richtlijnen van Roessingh Research and Development. Ik begrijp dat audiomateriaal of bewerking daarvan uitsluitend voor analyse en/of wetenschappelijke presentaties zal worden gebruikt. Ik geef toestemming dat de onderzoekers inzage kunnen krijgen in mijn onderzoeksgegevens. Daarnaast zal ik de smartphone die ik in bruikleen krijg niet voor andere doeleinden dan dit onderzoek gebruiken, dus alleen voor het gebruik van de Activity Coach applicatie.

Door dit formulier te tekenen geef ik toestemming voor deelname aan bovengenoemd wetenschappelijk onderzoek.

Naam deelnemer:

Plaats en datum:

Handtekening:

Naam onderzoeker:

Plaats en datum:

Handtekening:

Een kopie van het ondertekend toestemmingsformulier en de informatiebrief wordt aan de proefpersoon meegegeven.

Appendix C: Explanation of the technology

Explanation of the technology

1. Introduce the three devices: fitbit, scale and smartphone (intention: people now what to expect)
2. Show and explain Fitbit:
 - 2.1. It can be used on the pocket, belt or on the bra
 - 2.2. Should be used from the moment you get up till the moment you go to bed
 - 2.3. Don't forget to remove it from the clothes in the evening
 - 2.4. It is not water proof
 - 2.5. Touch the screen to show time, steps and smiley
 - 2.6. Let people experience it themselves
3. Show and explain scale:
 - 3.1. Recommendations for weight measurement are the same as with any other scale: no shoes, light clothes, try to measure your weight approximately at the same time
 - 3.2. You can weight yourself as many times you want; we are interested in seeing what is the actual use of the scale
 - 3.3. Explain that the phone needs to be in the proximity of the scale (less than 3 meters)
 - 3.4. Exemplify a measurement. Make it wrong on purpose so that people see the arrows when the weight is not well distributed
 - 3.5. Explain that a measurement is valid when the screen blinks
4. Tell that the default goal is 7500 steps but people can call asking to change
5. Show and explain the app:
 - 5.1. If the person does not know how to use a smartphone, teach how to lock / unlock screen, switch on and off, etc.
 - 5.2. Show where the app is on the phone
 - 5.3. Show and explain default screen for physical activity

- 5.4. Explain that the recommendation for 65+ is between 7000-10000 steps a day. We set the goal to 7500 but it can be changed to any value. If you think it is too high or too low call us
- 5.5. Show on the screen the “last update” from Fitbit
- 5.6. Show physical activity data from today and the past week. Use the manual to exemplify what people will see when using the app for longer periods
- 5.7. Show weight/bmi screens. Explain that it can take up to an hour to see the measurement on the screen
- 5.8. Emphasize that they are the first group of people using this app, we know it is not perfect, but we are very interested in knowing their opinion. Any thoughts about it are very valuable after the four weeks period.
6. Explain that people can make use of the app as they want. The only thing we ask is to answer the questions that will appear on the phone between 20.30 and 21.00 every night. ***This is very important for us.*** As a tip, tell people to check the app before going to sleep so they can answer the questions and see how active they were during the day. Show the questions in the manual.
7. Make it clear that the phone should only be used for this app. Any other use of the phone can come with charges for the subject (don't scare people but make them aware)
8. Tell that all information is in the manual and they can always contact any of us for questions.

Appendix D: Interview scheme 1st session (Dutch)

Interviewschema 1^e interview

- welkom (koffie/thee; cookies)
- uitleg van hele procedure
- informed consent geven & laten tekenen
- interview afnemen
- uitleg technologie
- nog vragen?
- bedanken

Het interview

- voorstel (naam, opleiding)
- onderzoek vindt plaats binnen het Langgezonderd/ PERSSILAA project.
- uitleg procedure: eerst wordt een interview afgenomen; dan uitleg technologie en meer informatie over onderzoek; tijd voor vragen

Het onderzoek vindt plaats binnen het Langgezonderd/ PERSSILAA project. U heeft een actieve rol in de ontwikkeling van een mobiele applicatie die zal worden gebruikt bij verscheidene doelgroepen voor het monitoren van fysieke activiteit. We willen dus inzicht krijgen in wat de behoeften zijn van de deelnemers om zo'n telefoon applicatie te laten voldoen aan deze behoeften. Uw mening is dus van erg belang!

Dus vandaag gaan wij een interview voeren van ongeveer 1 ½ uur. Wij zullen u een aantal vragen stellen over uw gezondheid en huidige gebruik van technologie. Daarna krijgt u een activiteitsensor en een telefoon in bruikleen voor een periode van 4 weken. Aan het einde van deze 4 weken hebben we opnieuw een gesprek, waarin uw ervaring met de mobiele applicatie wordt gevraagd. U krijgt van ons een informatiebrief waarin uitgebreide informatie over het onderzoek te vinden is.

*Als alles duidelijk is zouden we graag voordat het interview begint u willen vragen of het goed is om het interview op te nemen en of u het toestemmingsformulier wilt tekenen? → **informed consent geven & laten tekenen!***

Nu het formele gedeelte klaar is, kunnen we beginnen met het interview. Het interview bestaat uit eerst een aantal vragen over uw algemene gezondheid, en vervolgens zullen er vragen volgen over voeding, cognitie en fysieke activiteit.

BEGINNEN MET OPNEMEN!

Oke, dan nu eerst de vragen over uw algemene gezondheid.

1. Context/Algemene gezondheid

1.1 *Wat doet u in uw dagelijks leven om uw gezondheid bij te houden?*

1.2 *Zou u meer willen doen om uw gezondheid op peil te houden?*

1.3 *Is het belangrijk voor u om uw gezondheid bij te houden?*

1.3.1 Doorvragen: *Zo ja, waarom?*

1.3.2 Doorvragen: *Is het voor u belangrijk om uw gezondheid **dagelijks** bij te houden?*

Laten we het nu hebben over voeding. Nu volgen een aantal vragen die betrekking hebben op voeding.

2. Voeding

2.1 *Let u op uw voeding?*

2.2 *Vindt u het belangrijk dat u inzicht heeft in uw voedingspatroon?*

2.2.1 *Indien nodig een voorbeeld geven om een beeld te geven: zoals hoeveel calorieën u heeft gehad, wel opletten om antwoord niet te beïnvloeden?*

2.3 *Wat vindt u ervan om hulp te hebben bij het bijhouden van uw voedingspatroon van bijvoorbeeld een website of telefoon applicatie.*

2.4 *Zou u zo'n website of applicatie in uw dagelijks leven gebruiken?*

2.4.1 Doorvragen: *Wat zou u dan willen zien of bijhouden? → Wat zijn uw behoeften*

Zouden ze het alleen zelf willen zien of willen ze het ook delen?

Is het voldoende om het alleen te zien, of willen ze ook feedback/tips/begeleiding?

Dus wat is het doel van het bijhouden van deze informatie en hoe ga je dat doel bereiken.

Laten we het nu hebben over uw cognitie vaardigheden. Dus over geheugen, aandacht, concentratie.

Nu volgen een aantal vragen die betrekking hebben op cognitieve taken.

3. Cognitie

3.1 *Doet u iets om uw cognitieve vaardigheden op peil te houden?*

3.1.1 Indien nodig voorbeelden geven: Maakt u wel eens sudoku's, puzzels of geheugen spellen of lezen?)

3.2 *Vindt u het belangrijk om inzicht te hebben in de status van uw cognitieve vaardigheden, zoals uw aandacht vermogen en geheugen?*

3.3 *Wat vindt u ervan om hulp te hebben bij het bijhouden van uw cognitieve vaardigheden, zoals aandacht vermogen en geheugen van bijvoorbeeld een website of telefoon applicatie?*

3.4 *Zou u zo'n website of applicatie in uw dagelijks leven gebruiken?*

3.4.1 Doorvragen: *Wat zou u dan willen zien of bijhouden?* → Wat zijn uw behoeften

Zouden ze het alleen zelf willen zien of willen ze het ook delen?

Is het voldoende om het alleen te zien, of willen ze ook feedback/tips/begeleiding?

Dus wat is het doel van het bijhouden van deze informatie en hoe ga je dat doel bereiken.

Nu volgen een aantal vragen die betrekking hebben op fysieke activiteit.

4. Fysieke activiteit

4.1 *Wat doet u om fysiek actief te blijven?*

4.1.1 Verdere toelichting wanneer nodig: *Waarbij het niet alleen gaat om beweging, maar ook om bijvoorbeeld niet te lang op de bank te zitten, dus ook de kleine beetjes beweging.*

4.2 *In hoeverre beschouwt u uzelf als actief in vergelijking met andere mensen van uw leeftijd?*

4.3 *Wat motiveert u om lichamelijk actief te worden/te blijven?*

4.3.1 Indien alleen om gezond te blijven: *Waarom denkt u dat fysieke activiteit uw gezondheid bevordert?*

4.4 *Vindt u het belangrijk dat u inzicht heeft in uw beweeggedrag?*

4.4.1 Indien nodig verdere toelichting: *zoals een overzicht van het aantal minuten dat u op een dag bewogen heeft of heeft stilgezeten*

4.5 *Wat vindt u ervan om hulp te hebben bij het bijhouden van uw beweeggedrag via bijvoorbeeld een website of telefoon applicatie?*

4.6 *Zou u zo'n website of applicatie in uw dagelijks leven gebruiken?*

4.6.1 Doorvragen: *Wat zou u dan willen zien of bijhouden? → Wat zijn uw behoeften*
Zouden ze het alleen zelf willen zien of willen ze het ook delen?
Is het voldoende om het alleen te zien, of willen ze ook feedback/tips/begeleiding?
Dus wat is het doel van het bijhouden van deze informatie en hoe ga je dat doel bereiken.

5. Vragen naar andere parameters + mentale gezondheid/welbevinden (emoties)

We hebben het gehad over mogelijkheden die u zouden kunnen helpen bij het bijhouden van uw gezondheidsstatus ten opzichte van verschillende gebieden zoals voeding, aandacht, geheugen en beweging.

5.1 *Mist u nog andere gebieden die u zouden kunnen helpen bij het bijhouden van uw gezondheid?*

Als mentale gezondheid/welbevinden niet wordt genoemd, doorvragen:

5.2 *Vindt u het belangrijk om inzicht te hebben in uw dagelijkse welbevinden en/of emoties, bijvoorbeeld hoe u u voelt, of of u gelukkig voelt?*

Als mentale gezondheid/welbevinden wel wordt genoemd, doorvragen:

5.3 *Wat vindt u ervan om hulp te hebben bij het bijhouden van uw dagelijkse welbevinden via bijvoorbeeld een website of telefoon applicatie?*

5.3.1 *Indien nodig verdere toelichting: Met uw dagelijkse welbevinden bedoel ik hoe u u voelt of, of u u gelukkig voelde die dag?*

5.4 *Zou u zo'n website of applicatie in uw dagelijks leven gebruiken?*

5.4.1 Doorvragen: *Wat zou u dan willen zien of bijhouden?* → Wat zijn uw behoeften

Zouden ze het alleen zelf willen zien of willen ze het ook delen?

Is het voldoende om het alleen te zien, of willen ze ook feedback/tips/begeleiding?

Dus wat is het doel van het bijhouden van deze informatie en hoe ga je dat doel bereiken.

We zijn nu bijna aan het einde van dit interview, nu volgen er enkele vragen over technologie gebruik.

6. Technologie gebruik

Antwoorden aanvinken op basis van het gegeven antwoord.

In hoeverre is deze stelling op u van toepassing?

		geheel mee oneens	oneens	noch mee eens, noch mee oneens	eens	helemaal mee eens	Opmerkingen
6.1	<i>Ik ben in staat om mijn smartphon e te gebruiken. (self-efficacy)</i>						
6.2	<i>Ik denk dat ik een mobiele telefoon nooit geheel zal begrijpen. (anxiety)</i>						
6.3	<i>Waar gebruikt u uw mobiele telefoon voor? (current-use)</i>	0 bellen 0 sms-en 0 Whatsapp 0 mailen 0 apps 0 anders:					

Aandachtspunten voor de interview afname:

- Wanneer de respondent al komende vragen beantwoordt, vooral laten beantwoorden en vervolgens niet de vraag stellen.
- Alleen voorbeelden noemen wanneer de vragen onduidelijk is voor de respondent.
- Wanneer de respondent kort beantwoordt en er meer 'uitgehaald' kan worden, vooral doorvragen! Dit is vooral het geval bij de vragen over de telefoon applicatie/website (hulp van technologie).
- Let er op dat de focus steeds moet liggen bij de laatste doorvragen, dus over wat ze willen bereiken/doen met de gegevens die ze krijgen van een website of telefoon applicatie. → Dit is goede input voor het beantwoorden van de onderzoeksvragen!

→ Het is dus erg belangrijk om in te spelen in wat de respondent vertelt en proberen zoveel mogelijk informatie te krijgen die nuttig kunnen zijn bij het beantwoorden van de onderzoeksvragen.

Appendix E: Interview scheme 1st session (English)

Interview-scheme 1st interview

1. *Context/General Health*

1.1 *What do you do in your daily life to keep up your general health?*

1.2 *Would you like to do more to keep up your general health?*

1.3 *Is it important for you to keep track of your health status?*

1.3.1 If yes: *Why?*

1.3.2 If yes: *Is it important for you to keep track of your health status on a daily basis?*

2. *Nutrition:*

2.1 *Are you attentive towards your nutrition?*

2.2 *Do you find it relevant to monitor your nutrition? (If necessary give some examples like ingredients, calories, etc.)*

2.3 *What is your attitude towards the use of a website or mobile application to keep track of your nutrition?*

2.4 *Would you use such a website or mobile application on a daily basis?*

2.4.1 If yes: *What would you like to see/ Which feedback would you like to receive from such a system?*

3. *Cognition (attention, memory, concentration):*

3.1 *What are you doing to keep track of your cognitive skills? (If necessary give examples like sudoku, puzzles or memory games)*

3.2 *Do you find it relevant to monitor your cognition?*

3.3 *What is your attitude towards the use of a website or mobile application to keep track of your cognition?*

3.4 *Would you use such a website or mobile application on a daily basis?*

3.4.1 *If yes: What would you like to see/ Which feedback would you like to receive from such a system?*

4. Physical activity:

4.1 *What do you currently do to be/stay physically active? (If necessary explain that physical activity is not only about exercise but more about bodily activity in general. For example: housekeeping; walking/cycling instead of driving a car; etc.)*

4.2 *How active do you consider yourself compared to other people of your age?*

4.3 *What is your motivation to be/stay physically active?*

4.4 *Do you find it relevant to monitor your physical activity? (If necessary give an example like minutes active per day/minutes inactive per day)*

4.5 *What is your attitude towards the use of a website or mobile application to keep track of your physical activity?*

4.6 *Would you use such a website or mobile application on a daily basis?*

4.6.1 *If yes: What would you like to see/ Which feedback would you like to receive from such a system?*

5. *Other parameters (mental health/wellbeing)*

5.1 *Do you miss any other field besides nutrition, cognition, and physical activity which could help you to keep track of your general health? (If mental health/wellbeing is mentioned, go to question 5.3.)*

Actually we should have ask: *Do you miss any other component besides nutrition, cognition, and physical activity to capture/determine your general health status?*

5.2 *Do you find it relevant to monitor your mental health/wellbeing? (If necessary give examples like how often do you feel happy/glad/relaxed/stressed/etc.)*

5.3 *What is your attitude towards the use of a website or mobile application to keep track of your mental health/wellbeing?*

5.4 *Would you use such a website or mobile application on a daily basis?*

5.4.1 *If yes: What would you like to see/ Which feedback would you like to receive from such a system?*

6. *Technology use*

To what extent do you agree with the following statements:

		Strongly disagree	disagree	Nor agree or disagree	agree	strongly agree	remarks
6.1	<i>I am able to use my mobile phone. (self- efficacy)</i>						
6.2	<i>I think I would never completely understand a mobile phone. (anxiety)</i>						
6.3	<i>What do you use your mobile phone for? (current- use)</i>	0 to call 0 to message 0 WhatsApp 0 to mail 0 to use apps 0 other:					

Appendix F: Interview scheme 2nd session (Dutch)

2nd interview questions: (phone erbij hebben!)

Functional perception

1. *Welke functies van de FitBit/ActivityCoach vindt u het meest belangrijk?*
2. *Welke functies van de FitBit/ActivityCoach vindt u het minst belangrijk?*
3. *Welke informatie zou u nog willen zien, die er nu niet in zit?*

Visual perception (Colour, size of letter)

4. *Welke schermen van de applicatie bevallen u het meest?*
5. *Welke schermen van de applicatie bevallen u niet?*

Wanneer geen relevante antwoorden gegeven worden, deze vragen nog stellen om dieper informatie te krijgen:

6. *Wat waren voor u de grootste zwaktes tijdens de vier weken?*
7. *Wat waren voor u de grootste sterktes tijdens de vier weken?*

Subjectieve ervaring van de gebruiker

8. *Bent u door het gebruik van de FitBit/ActivityCoach lichamelijk actiever geworden?*
9. *Wat denkt u over het stappendoel per dag van 7500?*
10. *Wat vindt u ervan dat u met de Activity Coach uw gewicht en BMI bijhoudt? OF: Vind u het nuttig om u gewicht en BMI bij te houden?*
11. *Bent u bewuster geworden van uw welbevinden door het dagelijks antwoorden van de vragen?*
Doorvragen: Had het voor u een toegevoegde waarde of heeft het iets voor u opgeleverd?

Afsluitende vraag

Samenvatten wat er besproken is, de plus en minpunten van de applicatie enzovoort, vervolgens vragen:

12. *Wat vindt u van de mogelijkheid/idee om u fysieke activiteit bij te houden met behulp van de mobiele applicatie?*

Appendix G: Interview scheme 2nd session (English)

2nd interview questions: (during the interview having the phone in front of the user!)

Functional perception

1. *Which features of the FitBit / Activity Coach do you consider as the most important?*
2. *Which features of the FitBit / Activity Coach do you consider as the least important?*
3. *Which information would you like to see that is currently not included?*

Visual perception (Colour, size of letter)

4. *What screens of the application do you like the most?*
5. *What screens of the applications do you not like?*

When no relevant answers are given, yet asking these questions to get deeper information:

6. *What were the biggest weaknesses during the four weeks for you?*
7. *What were the greatest strengths during the four weeks for you?*

Subjective experience of the user

8. *Did the use of the Fitbit/Activity Coach motivate you to become more active?*
 9. *What do you think of the goal of 7500 steps per day?*
 10. *What do you think about the fact that the Activity Coach monitors your weight and BMI? OR: Do you find it useful to monitor your weight and BMI?*
 11. *Did you become more aware of your wellbeing by answering the questions daily?*
- Ask further: Did it had an added-value for you?*

Concluding question

Summarizing what has been said, the advantages and disadvantages of the application and so on, then asking:

12. *What do you think about the opportunity/idea to monitor your physical activity by using the mobile application?*

Appendix H: Code scheme

Code Family	NUTRITION	COGNITION	PHYSICAL ACTIVITY	OTHER DOMAINS
Codes	Attentive	Keeping up	Being/staying active	<u>Wellbeing</u>
	Insight in diet	Insight in cognition status	Comparison	Help from technology
	Help from technology	Help from technology	Motivation	Intention to use the tech.
			Insight in physical activity	
			Help from technology	Physiological parameters
	<u>Using technology</u>	<u>Using technology</u>	<u>Using technology</u>	
	<i>Intention to use</i>	<i>Intention to use</i>	<i>Intention to use</i>	
	<i>What to track/monitor</i>	<i>What to track/monitor</i>	<i>What to track/monitor</i>	
	<i>Aim</i>	<i>Aim</i>	<i>Aim</i>	
	<i>Consequences</i>	<i>Consequences</i>	<i>Consequences</i>	
	<i>Share</i>	<i>Share</i>	<i>Share</i>	

Appendix I: Outcomes technology use questions

user	gender	self-efficacy <i>I am able to use my mobile phone.</i>	anxiety <i>I think I would never completely understand a mobile phone.</i>	current use <i>What do you use your mobile phone for?</i>	smartphone 0=no 1=yes
user01	m	3	4	calling, Whatsapp	1
user02	f	4	4	everything	1
user05	f	4	4	calling, sms	0
user06	f	2	4	calling	0
user07	m	4	4	everything	1
user08	f	4	3	everything	1
user11	m	4	2	everything	1
user16	f	3	4	calling, Whatsapp	1
user17	m	4	2	calling, Whatsapp, email	1
user18	f	1	4	calling, sms	0
user19	f	4	4	calling, sms	0
user20	m	5	2	everything	1
General					
<i>M</i>		3,50	3,42	total smartphone	8
<i>SD</i>		1,09	0,90		