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Self-management application design on salt intake and blood pressure for seniors

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Self-Management Application Design on Salt Intake and Blood Pressure for Seniors

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活到老学到老

Live and learn.
Acknowledgements

It is with great pleasure and no small amount of pride that I present to you my thesis on “Self-Management Application Design on Salt Intake and Blood Pressure for Seniors”. It is the result of a long journey for me, both physically and mentally. It all started in my hometown, Hsinchu (Taiwan), over two years ago and back then I could never have imagined how much my life would change because of this endeavor. Doing the research, reviewing papers, developing an app out of nothing, all of these things taught me a great deal and it will benefit me for the rest of my life. However, it is the people who helped throughout this journey that have changed me the most. Therefore I would like to express my sincere appreciations to all those people who in some way contributed their knowledge, support and time to help me accomplish this study. There are some people who I want to mention specifically and thank from the bottom of my heart.

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Summary

Hypertension is a common condition worldwide and is especially prevalent among seniors. Modifying lifestyle plays an important role in hypertension control. Among those factors of lifestyle, the amount of salt intake has a great influence on blood pressure. However, apps focusing on salt intake management are rarely designed for seniors.

In this project, we designed a health self-management app for seniors and aimed to study and improve the usability of this app as well as the seniors’ attitudes towards this kind of apps. We first reviewed the existing studies and the design guidelines of apps and websites for seniors. Then, we adopted a user-centered design methodology to develop a health self-management app on salt intake and blood pressure documentation for seniors with hypertension. Three iterations of user studies which included interviews, usability tests and surveys were carried out in a lab-setting environment to evaluate our design and gain the opinions from users. With the findings from each iteration, we refined the design in order to improve the usability to support seniors’ needs and maximize the benefits for users.

The results from this project showed that in the user interface design, well-designed pictures can improve the efficiency for seniors and the important elements should be placed in the center area of the screen. The flow of the app should be intuitive by combing relevant tasks. Additionally, although a flat-structured menu is often suggested, the design should take the number of functionalities and the length of each task in the app into consideration. Finally, in order to improve the learnability, an instruction should be provided.

Besides the design of app, we found some barriers and drivers of adopting the health self-management app. Generally, the participants believed they already lived a healthy life and had no need to change it. It seems to be challenging to modify their lifestyle. Our study suggested that for seniors, the accurate and effective information providing in the health apps could especially earn their trust and benefit them. Although seniors can easily obtain information on the Internet these days, the prompt information can increase their awareness of their condition and change their lifestyle. From the view of technologies, the accessibility of technologies plays an important role. The stability and ease to use determine whether to use a technology continuously. Mentally, the difficulty was to cope with the worry of realizing their conditions. Finally, the involvement of doctors and professionals could promote the importance of self-management in health.
6.3.3 Usability Test ................................................................. 39
6.3.4 Interview ........................................................................... 42

Chapter 7 ............................................................................................ ....................................... 46
Experience on Hypertension Control and Attitude towards the Health Self-management Tool ..... 46
7.1 Introduction..................................................................................... 46
7.2 Interview and Questionnaire ................................................................. 46
7.2.1 Interview ..................................................................................... 46
7.2.2 Questionnaire ............................................................................. 46
7.3 Results ................................................................................................. 47
7.3.1 Data Analysis .................................................................................. 47
7.3.2 Interview ..................................................................................... 47
7.3.3 Questionnaire ............................................................................. 58

Chapter 8 Discussion and Conclusions .............................................................. 61
8.1 Discussion .......................................................................................... 61
8.1.1 Usability and the Need of the Health Self-Management Tool ....................... 61
8.2.2 Attitude towards the Health Self-management Tool ........................................ 62
8.2 Limitations and Future Work ........................................................................ 63
8.3 Conclusions ......................................................................................... 63

Bibliography ......................................................................................... ...................................... 64

Appendices ........................................................................................... ..................................... 59
Appendix A Apps on Salt Intake ........................................................................ 59
Appendix B Interview Questions of the First Iteration .................................................. 60
Appendix C Demographics and Technology Use Questionnaire (in Dutch and English) ........... 62
Appendix D Interview Questions of the Second and Third Iteration ................................. 65
Appendix E Codes of the Interview Data Analysis ......................................................... 66
Chapter 1

Introduction

Hypertension is a prevalent public health problem worldwide which rises with age. Particularly after the age of 50, more than 50% of the population are affected (Mancia et al., 2014). The number is still increasing because of the growing population and aging society. WHO’s statistical data from 2014 shows that hypertensive heart disease is one of the top causes of death. Sufficient management of blood pressure is needed to enhance the life quality and prevents other consequent diseases such as stroke and cardiovascular diseases.

At the same time, people’s independence decreases with age. As life expectancy becomes longer and because of declining birth rate, there will be fewer people able to generate income to support the health care for seniors. The demand of staying healthy for longer increases and the need for maintaining life independence for seniors raises. Using technology in health care (e.g. mobile health, e-health) is a trend nowadays. Having the advantages of mobility and instant communication, apps on mobile devices can potentially achieve the goal of lifestyle modification and living independently for seniors.

However, the mismatches between user requirements and the existing apps can form barriers towards adopting new technologies. This happens especially for seniors because their declines in cognitive and physical abilities increase the difficulties of adopting new technologies and many seniors are not capable of using the technologies with a universal design (Or and Tao, 2012).

In this project, our target users were seniors (>65 years old) with hypertension. Our goal was to understand the usability requirements of seniors, and design and assess the health self-management app which can support hypertension control for seniors. Additionally, we investigated their attitude towards this app. The concept of this project is shown in figure 1-1.

![Figure 1-1. The concept of this project](image-url)
This thesis is organized as follows: we will first introduce the background knowledge of hypertension and current research about self-management apps in Chapter 2. Then we present our design and user study methodology in Chapter 3. From Chapter 4 to Chapter 6, we describe the app development, the usability assessment approach and the results of each iteration. In Chapter 7, we integrate the findings with respect to the attitude towards the self-management apps and the technology literacy from the interviews and questionnaires in three iterations, and display the results. Finally, we conclude and discuss the findings, the limitations of this project and future work in Chapter 8.
Chapter 2
Background

2.1 Introduction

In this chapter, the background knowledge for this research is introduced. First of all, Section 2.2 introduces the general knowledge of hypertension and the importance of blood pressure management for seniors. Section 2.3 presents the existing self-management approach in hypertension. It contains the reason for using the self-management approach, the role of technology in the self-management approach, and what applications exist in the market. Section 2.4 discusses the acceptance of technology and what difficulties seniors face when adopting technology, even if it is designed for seniors. In section 2.5, we define our research questions.

2.2 Background Knowledge of Hypertension

Hypertension is defined as the systolic blood pressure higher than 140 mm Hg or and diastolic blood pressure higher than 90 mm Hg. There are several factors causing high blood pressure. Unhealthy dietary behavior, for instance, too much salt consumption, harmful alcohol intake, smoking, lack of exercise, excess weight, age, genetic and persistent stress have an impact on the development of hypertension (Mancia et al., 2014).

Regarding the symptoms of hypertension, hypertension is recognized as a “silent killer” because most people with hypertension do not have any symptoms. As a result, the significance of hypertension management is also usually neglected which may cause more harmful consequences. Hypertension has been confirmed as having a relation with a high risk of cardiovascular disease, stroke, dementia and kidney diseases (Glynn et al., 2010). It is proven that maintaining the blood pressure under 140/90 mm Hg can efficiently reduce the cardiovascular risk (Farrell et al., 2014). However, it is not clear whether this recommended goal can be applied to all elderly people (age>65) due to the high variability in blood pressure and hypertensive phenomena (Barochiner et al., 2015) which makes the treatment of high blood pressure complicated for elderly people.

Blood pressure management can be achieved through lifestyle modification and medication when necessary. Besides this, self-monitoring of blood pressure can help to detect abnormal conditions to further modify treatment or ask for advice from professionals, especially for those people who are constrained in reaching medical resources due to physical and geographical reasons.

2.3 Self-management Approach in Hypertension Management

2.3.1 Why Self-management?

The treatment of high blood pressure is usually ignored because of its symptomless condition (Hallberg et al., 2016). In a study by Bengtsson et al. (2016), the low adherence to medication was the main cause of poor blood pressure management. Only 25%-40% of the patients who took medication as treatment reached the target blood pressure levels (Glynn et al., 2015). In a previous study, it was discovered that patients’ view and the perceived symptoms will have a strong influence
on the adherence and maintaining of behavior change (Bengtsson et al., 2014). Besides the traditional pharmacological treatment, nowadays lifestyle modifications, education and self-management are included in the guidelines of hypertension management (Bengtsson et al., 2016). In their previous studies, Glynn et al. (2010) reviewed 72 studies using non-pharmacological interventions. It was evident that along with medication, self-monitoring helped to decrease the blood pressure. In the approach of blood pressure control proposed by Go et al. (2014), they indicated that an appropriate lifestyle modification could reduce the blood pressure from 2-20 mm Hg. For instance, losing weight can approximately reduce 5-20mm Hg/kg; adopting DASH diet can reduce 8-14 mm Hg; lowering sodium intake can reduce 2-8 mmHg; engaging in regular physical activity can reduce 4-9 mm Hg; limited alcohol consumption can reduce 2-4 mm Hg. A self-monitoring system can also be a means to increase the understanding of the relationship among the treatment, blood pressure level and other symptoms, and, furthermore, to improve the adherence to medication (Bengtsson et al., 2014).

Besides self-monitoring, an app can include interactive educational information, suggestions and reminders, which has been shown to facilitate more reduction in blood pressure compared with normal care alone (Kumar et al., 2015).

2.3.2 Role of Technology in Self-management Approach

With the widespread availability of internet access and powerful computing capacity of mobile devices, mobile-health (m-health) technology is a potential approach to provide such interactive digital interventions. Additionally, the strong attachment relationship between human and device has a great impact on human behavior (Glynn et al., 2015). People interact with their mobile devices regularly which is strengthened by the instant communicated information or rewards. It empowers users to monitor their health, make decision to change behavior, receive personalized coaching messages, get real-time feedback or interact with professionals. This influence has emerged in promoting physical activity by many applications. This approach may also increase the motivation to follow the treatment and maintain certain behaviors when users are aware of the interplay between blood pressure and lifestyle (McLean et al., 2015). Bengtsson et al. (2016) performed a longitudinal study with a self-management tool which consisted of self-reported measurements, reminders and motivation messages and feedback of self-reported data, and they found a significant reduction in blood pressure.

Among these mobile devices, while smartphones were much more popular than tablets in younger people, the ownerships of smart phones and tablets were 30% and 32% for seniors (age>65) in the United States in 2015 (Anderson, 2015). Tablets have the advantage of larger screen, but smart phones have better mobility. Kobayashi et al. (2011) conducted a study to evaluate the performance of interacting with small screen devices and larger screen devices for seniors. It was proved that seniors performed better on a larger screen than on a small screen device, even in those gestures which required longer finger movements. However, no significant difference in the accuracy of performing complex gesture on a smartphone and a tablet was found for elderly in the study by Lilian et al. (2014). The performance could be improved by practicing and also depended on their experience with technologies, age and use situations (Motti et al., 2013).

2.3.3 Existing Applications and Studies

Some studies on hypertension self-management applications were found. One self-report hypertension system was designed by Bengtsson et al. (2014). This system included 12 daily
questions and 4 weekly questions using Likert scales about biological markers (i.e. blood pressure, pulse), symptoms, medication side-effect, treatment adherence, quality of daily life and lifestyle to assess the health condition. They explored the validation of the items in the system and the usability by interviewing the participants aged from 49 to 82. The results showed that the system was simple to use and the questions were relevant and able to cover the information in hypertension management.

Hallberg et al. (2016) developed a self-management system which contained an application on a mobile phone to report self-health status and receive reminders and motivational messages, a device for measuring blood pressure and a web-based application to look up history data. They interviewed participants aged from 37 to 81 with hypertension after they used the system for 8 weeks. The system was considered easy to use. The participants found that using this system increased the involvement in the following consultations. Also, they were more motivated to follow the treatment because of understanding the interplay between blood pressure and lifestyle. As a result, the increased awareness of the importance of treatment adherence helped to manage the blood pressure better.

Another study focused on the experience of using the self-management tool for hypertension (Glynn et al., 2015). They concluded that every user is unique in the use of the application, so that adequate flexibility and personalization should be provided. Trust is also an issue to be overcome. The trust issue included the trust in the healthcare provider, trust in the reliability of the machine or application, and the improvement of condition by changing behaviors. Moreover, the motivation was affected by many factors such as personal knowledge and perception of risk. It can be facilitated by personalized coaching messages, educational information through technology, and communication between the individual and the doctor or healthcare provider.

A review on smartphone-based applications for hypertension management was performed by Kumar (Kumar et al., 2015). They reviewed 107 apps on iPhone and Android phones in May 2014. Major functionalities were: tracking, hypertension education, medication adherence and transforming phone into a medical device by measuring heart beat rate and blood pressure. About 72% apps had one or more tracking or recording functions. It included heart rate, blood pressure, weight, calorie intake and salt intake. About 37% apps had education functions such as general information, Dietary Approaches to Stop Hypertension (DASH) diet, alternative treatments and professional assistance tool. However, only about 3% apps had a salt intake tracking function.

With regard to salt intake tracking, there are some methods used to estimate it. A 24-hour urine test is considered the most accurate way (McLean, 2014). Besides the biological examination through urine, salt intake can be estimated by dietary assessment. Dietary recall and weighted diet records are generally used. It is laborious and usually under-estimated but enables the possibility of revealing the source of sodium. Another approach to estimate salt intake is by answering the Food Frequency Questionnaire (FFQ) which characterizes taste preference and dietary behavior (Takachi et al., 2014). In the questionnaire, people indicate the frequency of consuming the foods in the list in the past year. The list usually consists of more than 100 foods which are sodium-rich or usually consumed with salt when eating (Venezia et al., 2010). It assesses salt intake over a longer period and the variation of salt intake from day to day can be average. Takachi et al. (2014) concluded that the results from of taste preference from FFQ and the 24-hour urine test were significantly related.

Among the apps of salt intake estimation that we found for iPhone and Android phones (See appendix A), using a nutrient database which contains either restaurants or package food to estimate salt amount is the most common approach. Users can enter the data of food from the database. The
accuracy will depend on the completeness of the database and the dietary behavior. Besides the nutrient database, the other method is filling in the amount of salt that users put in when cooking and eating to track daily salt intake.

Among the applications of hypertension management applications and studies, we could not find a single one particularly designed for elderly people.

2.4 Acceptance of Technology for Seniors

As we can see from the previous section, self-management hypertension applications are rarely tailored to seniors. However, this may induce the non-adoption issue because of the usability of the application and senior people’s attitudes towards technology. How these factors affect the acceptance is important to understand from both technological and human perspectives. In this section we will present the usability barriers along with usability problems of the self-management health application found from previous studies, and attitude barriers.

2.4.1 Usability Barriers

There are many barriers that seniors have when interacting with technology. These barriers can be categorized into physical barriers and the technology design barriers (Fletcher et al., 2015).

**Physical Barriers**

Physically, seniors are experiencing the decline of ability in cognition, perception and motor control due to the normal aging process. The cognitive decline encompasses the decrease of working memory, decrease of spatial acuity, decrease of both selective and dynamic visual attention, and ease of affecting by salient events (Fisk, 2004). These declined abilities will affect decision making and processing speed which result in more error occurrences and poorer performance. Due to the decrease in the ability of working memory, learning new skills or metaphors should be avoided and instead the items from their past that they can recognize easily should be used.

The second physical barrier is due to the change in perception ability. Problems in eye acuity become noticeable around 40 years old (Fisk et al., 2004). In addition to the effect on reading, visual decline also has impact on sensitivity to glare and to color contrast. Hence, it takes longer to adapt to the darkness and it is more difficult to distinguish colors with low contrast especially in the range of blue and green (Phiriypakanon, 2011). Age-related decline also happens in hearing. High frequency sound (over 2500 Hz) may be inaudible for some seniors (Phiriypakanon, 2011).

The last one is the decline on motor control. The movement becomes less accurate and more variable which influences fine skills particularly. Also, the movement tends to be slower than in younger adults. When designing applications on a touch device or with mouse control, the need for longer response time (e. g. double click) and bigger clickable targets has to be taken into consideration (Fisk, 2004; Fletcher et al., 2015).
From the aspect of technology design, although the use of technology is growing in elderly people, there is still an age-based digital divide (Gudur et al., 2013). Common technology is often developed for the majority of users. When designing an application, the lack of consideration of the aging process results in a barrier for adopting new technologies (Fletcher et al., 2015). Many applications are designed by people from a younger generation and do not reflect the needs for elderly people. One obvious issue is the icons are difficult to recognize (Fletcher et al., 2015). The visual presentation and metaphors which younger people are familiar with are not so explicit to elderly people. In addition, menu structure and functions that are too complex is another common issue (Hölzl & Schaffer, 2013). For instance, the nested menu makes elderly users get lost in the application easily. These designs form the barrier for adopting new technology for seniors.

Or and Tao (2012) examined the usability of a self-management health system for seniors with chronic diseases. They indicated several usability problems. For instance, the design inconsistency of appearance and position of items with same function across pages caused confusion, which increased the search time. The second problem was too many options resulted in higher decision making complexity. It would take longer time in visual search and cognitive effort. With regard to information presentation, abbreviations or medical terms were too technical to understand for elderly people. Finally, elderly people encountered difficulty in pairing the date with corresponding measurements in the line chart presentation of history data. Hence, a graphical presentation should be designed to facilitate the measurement retrieval.

Another study on application design for seniors by Hölzl and Schaffer showed the usability problems of manipulating a touch device (Hölzl & Schaffer, 2013). One main problem they found was the design of haptic feedback. As a means of feedback, vibration was too weak to be noticed by seniors in current mobile phones.

The numeric input method in a mobile medical application for managing chronic diseases for seniors was discussed in the study by Nischelwitzer et al. (2007). They evaluated different methods of data input and found the calculator-style number keypad was most favorable. The slider-style input method on touch device required more precise motor control so that it was not suitable for seniors.

2.4.2 Attitude Barriers

Generally, elderly people are motivated to use technology when they feel the need and believe that technology can help their life (Caprani et al., 2012). Their age, education and prior technology experience influence their attitude towards technology (Caprani et al., 2012). There are some common barriers resulting in decreasing the use of technology. First of all, because of the lack of prior experience, they may underestimate their abilities and overestimate the effort for adapting to new technology. This can cause the low perceived technology self-efficacy and comfort (Fletcher et al., 2015), and furthermore, results in technology anxiety (Gudur et al., 2013). Secondly, when learning to use new technology with little prior knowledge, they may feel frustrated after a while and this leads to the lack of perceived ease of use (Fletcher et al., 2015). One more barrier to modify the attitude is the perceived usefulness. Because they are new to these technologies and are not aware of how it can improve their life and benefit them (Fletcher et al., 2015). Finally, especially for health application and monitoring function, the privacy and security concern become the barriers (Fletcher et al., 2015). They worry about the inappropriate use and access of data by the unauthorized people.
2.5 Research Questions

From the literature review and existing apps review, we confirmed that mobile health technology can have the potential to influence people’s life style and prevent severe conditions from developing. However, it was evident that no existing app on salt intake management was tailored to seniors to help them control their blood pressure. In order to maximize the benefit of health self-management app for seniors, we developed a prototype of salt intake and blood pressure management tool for seniors and the following questions were investigated:

Main question: What are the drivers and barriers in user acceptance of health self-management tools, tailored to a senior population dealing with hypertension?

(1) Usability and the need of the health self-management tool
   a. What is elderly’s preference of platform, user interface and interaction of the blood pressure management tool?
   b. What functions do elderly people need in the blood pressure management tool?

(2) Attitude towards the health self-management tool
   a. What is the motivation of adopting the blood pressure management tool for elderly?
   b. What is the expectation of the seniors towards the blood pressure management tool?
   c. How can seniors benefit from using the blood pressure management tool?
Chapter 3

User-centered Application Design

3.1 Approach

In order to discover the usability and acceptance of the self-management health tool for elderly, a user-centered iterative design and evaluation method was used. By using such a design method, target users got involved in the early stage of the whole development procedure and brought human insights into the design. To get the information about users’ capabilities, requirements, and expectations rapidly, a low fidelity (lo-fi) prototype was an efficient method. It was an early version and incomplete prototype of an application which had the advantages of low time and money cost and high flexibility. In this stage, it was aimed to examine the user interface, concept, layout and design alternatives. Paper prototyping was a method used to build a lo-fi prototype. It enabled people who did not have a technical background involve in the design. In our project, a digital interactive prototype was developed using Microsoft Powerpoint. The digital prototype could be modified easily and users could interact with the prototype naturally on a real device. The feedback from users was incorporated to refine the prototype. Finally, a high fidelity (hi-fi) prototype with complete functionality was built.

We had three iterations of design and evaluation. The procedure is shown in figure 3-1. First of all, a lo-fi prototype was built. Based on the literature and existing competitors, the requirement and the context were defined. We learned that lowering sodium intake could reduce blood pressure significantly. However, salt intake self-management apps were rare. Hence, we chose to focus on salt intake and blood pressure monitoring. In the first iteration, a qualitative study was conducted to gain the opinions on the preference of functionalities, platform and user interface for elderly people. In the second iteration, the visual presentation and application flow were refined with the findings from the first qualitative study. In the first usability study, an interview and survey were performed in order to evaluate the application flow, interaction as well as the user interface. After two iterations, a hi-fi prototype was developed. Besides evaluating the user interface, application flow and interaction, usability was assessed by a usability test, interview and survey. All three studies were approved by the Philips ICBE ethic board.

Figure 3-1. User-centered design procedure
3.2 Participants

Our target users were people who were older than 65 years old and had been diagnosed with hypertension. Additionally, in order to gain the insights from users efficiently, the following selection criteria were added: no severe cognitive decline and a sufficient ability in the English language. The participants were recruited through an external agency: CG Selecties. See the participants’ details in the following chapters.

3.3 Design Guidelines

The prototype was developed with the reference of the design guidelines for elderly people. There is a considerable amount of research published on the design guideline of technology and applications on mobile devices for elderly people. We extracted and refined design guidelines by reviewing the literatures on (1) general design guidelines for elderly (2) touch-based user interface design for elderly people, and categorized them into: visual and auditory presentation design, interaction design, and cognitive design.

3.3.1 Visual and Auditory Presentation Design

With the influence of aging, the visual capability of elderly people is decreasing. Design of text and color should take this into consideration. The design guidelines for text are:

- Size 14 or higher with sans-serif fonts is preferred (Phiriypakonan, 2011; Caprani et al., 2012; Loureiro & Rodrigues, 2014)
- To make the texts more readable, fancy animations and italics, underlining, and uppercase texts which will lead to slow reading should be avoided (Phiriypakonan, 2011; Verdezoto & Grönvall, 2012; Loureiro & Rodrigues, 2014)

The use of colors is another important issue for the elderly users. The perceptual decline reduces the signal-to-noise ratio and the sensitivity. There are several ways to help to enhance the signal:

- Increase contrast (Olwal et al., 2011; Caprani et al., 2012; Verdezoto & Grönvall, 2012; Loureiro & Rodrigues, 2014))
- Avoid short wavelength (blue – violet – green) contrast (Verdezoto & Grönvall, 2012; Loureiro & Rodrigues, 2014)
- Avoid background with complicated pattern, especially text display regions (Verdezoto & Grönvall, 2012)

When including graphics, the element should be easy to recognize and not capture unnecessary attention. Some guidelines are:

- Use icons along with texts (Loureiro & Rodrigues, 2014)
- Use relevant graphics (Loureiro & Rodrigues, 2014)
- Avoid blinking, over-decorated, animated graphic (Loureiro & Rodrigues, 2014)

Regarding the use of audio, the ability of hearing is decreasing with aging which makes it difficult to hear certain frequency of sound.
Avoid sound with frequency higher than 4000 Hz and try to keep it within 500 to 2000 Hz (Fisk et. al, 2004)

Because of the physical decline, the selected targets (e.g. button) have to be larger than a certain size. The recommended design of a target is:

- Minimum length: 8 mm; size: 16.5 mm² (Verdezoto & Grönvall, 2012; Loureiro & Rodrigues, 2014)
- Space between targets: 3.17-12.7 mm (Caprani et al., 2012; Verdezoto & Grönvall, 2012)
- The clickable target should be obviously identified

Finally, some more guidelines for the layout and the content presentation can be used to enhance the usability.

- Place attentions in the center (Phiriyapokanon, 2011; Verdezoto & Grönvall, 2012)
- Remove irrelevant information (Dalgaard et al., 2013; Loureiro & Rodrigues, 2014)
- Provide only one open window (Loureiro & Rodrigues, 2014)
- Use simple language, positive phrasing (Loureiro & Rodrigues, 2014)
- Redundancy of content may give higher benefits (e.g.: texts + images, texts + voice) (Phiriyapokanon, 2011)
- User real object-liked interface (Phiriyapokanon, 2011; Verdezoto & Grönvall, 2012)

### 3.3.2 Interaction Design

Considering the physical decline, decline in divided attention and technology literacy, the gestures needed to manipulate the interface and the data entry method should be tailored to seniors.

- Avoid scrolling and double tapping (Caprani et al., 2012; Loureiro & Rodrigues, 2014; Olwal et al., 2011; Phiriyapokanon, 2011; Verdezoto & Grönvall, 2012)
- Provide predefined value (Caprani et al., 2012)
- Use virtual keypad instead of other entry device in order not to divide the attention (Caprani et al., 2012)

After every action, it should give proper response at the appropriate time. This will help to guide them to the next step.

- Rapid and noticeable feedback (Phiriyapokanon, 2011)
- Use visual, auditory or haptic output (Caprani et al., 2012; Olwal et al., 2011; Verdezoto & Grönvall, 2012)

Finally, due to the loss of working memory, the design of the application should be easy to navigate for the elderly. There are several strategies to design the menu.

- A flat navigation tree is most efficient. It needs less working memory to remember the spatial location than in a nested menu (Gudur et al., 2013; Hözl & Schaffer, 2013; Loureiro & Rodrigues, 2014; Verdezoto & Grönvall, 2012)
- Use a progress bar to indicate where the user is (Gudur et al., 2013; Loureiro & Rodrigues, 2014; Phiriyapokanon, 2011; Verdezoto & Grönvall, 2012)
- Minimize the number of steps to reach a certain page (Loureiro & Rodrigues, 2014)
3.3.3 Cognitive Design

Most technological products and applications are not specifically designed for elderly people. However, for them the cognitive decline and the averagely low technology literacy increase the difficulties when starting to adopt a new technology. In order to reduce the learning time and boost their motivations, the technical support and error prevention should be carefully designed.

- Clear instructions or manual can reduce the barrier of using the application in the beginning. (Phiriyapokanon, 2011)
- Provide on screen help or wizards within the operating page instead of a separate file. This can be used to avoid switching among pages so they can follow the instructions in the same page (Phiriyapokanon, 2011)
- Make reversing, terminating, and resuming an act and correcting input errors simple and clear (Loureiro & Rodrigues, 2014; Phiriyapokanon, 2011; Verdezoto & Grönvall, 2012)

When designing a task for elderly, we should try to reduce the working memory and cognitive loads. Some guidelines are:

- Keep a task as simple as possible (Phiriyapokanon, 2011)
- Reduce number of options (Fletcher & Jensen, 2015; Loureiro & Rodrigues, 2014)
- Make the structure of a task clear. For instance, recognizable starting and ending point, single task per page and place confirmations of acts by users (Phiriyapokanon, 2011)

Moreover, there are some other general design guidelines for cognition decline:

- Give them time to read, to learn (Loureiro & Rodrigues, 2014)
- Use recognition rather than recall in a task (Loureiro & Rodrigues, 2014)
- Focus on learnability and memorability. Use familiar metaphors to take the advantage of using their experiences, because it takes more effort for them to learn new concepts. (Loureiro & Rodrigues, 2014; Phiriyapokanon, 2011)
Chapter 4

First Lo-fi Prototype

4.1 Prototype Design

The first lo-fi prototype was built using Microsoft Powerpoint 2013 in which users could go through the application by a sequence of clicking.

4.1.1 Functionality

The functionalities in this prototype included a salt intake journal and the record of blood pressure measurements.

In the salt intake journal, a list of food containing salt is shown to estimate the amount of salt intake. Since the dietary habit is highly related to the country people live in, the materials and information used in this application are from Nierstichting (Kidney Association, the Netherlands) (Nierstichting, 2016). Besides salt intake, users can enter their blood pressure measurements in the application. With these two functionalities, users can attain the information about the sort of food that has a high salt amount and track the relation of the salt intake and the blood pressure.

4.1.2 Platform

In this first stage, we chose laptop, tablet and mobile phone to present the prototype in order to get users’ preferences of the platform. Except for the button size, the same design was applied to all these three platforms. The details of the designs will be described in Section 4.1.4.

The devices used in this study were HP EliteBook 840 G2 notebook with 14” screen, Apple iPad 3 with 9.7” screen and Apple iPhone 6 with 4.7” screen. We assumed that tablets would be most favorable to seniors because it combines the advantages compared to laptop and mobile phone, which are: mobility and larger screen respectively.

4.1.3 Application Flow

To help users navigate through the functionality a pro-active chatting wizard was designed. A series of questions pop up on the left side of the screen to guide the users to the following steps. Users answered each question from the pre-defined options in the right side of the screen. An example is shown in figure 4-1.
To further help users, a navigation bar in the top right of the screen informed them where in the application they were. An example is shown in figure 4-2.

Based on the previously mentioned design guidelines, the application was developed with as few layers as possible in the menu structure. Therefore there was only one layer and no main menu. We also applied the guideline of reducing the number of options per function to a minimum by reducing it to one task at a time. Users would be taken to the corresponding page via the interactive chatting wizard to complete the function. For instance, in the food journal, users would first be guided to the page of a list of foods and be asked to select the food they ate. Then, they went on to the second step in which they entered the amount of each food. In the end the result of salt intake was presented. The flow is shown as figure 4-3.
Figure 4-3. The flow
4.1.4 Visual Presentation

The same font design was applied to the three different platforms. The font type and size of the information description in the app were Calibri 24; the font type and size of the general buttons were Calibri 32; the descriptions of the foods was in font Alright Sans with size 20 to 24; the font and size in the progress bar were Calibri 20; the font and size in the numeric keypad were Calibri 44. An example of information description and general buttons is shown in figure 4-4.

In the design of buttons, in order to follow the design guideline in 3.3.1, the sizes of general buttons and the buttons on the footer bar (see figure 4-5) on the phone were adjusted. On Apple iPhone 6, the size of a general button was 1.5*0.85 cm$^2$, the buttons in the footer bar were 1.5*0.8 cm$^2$ the smallest, the buttons in numeric keypad was 1.25*0.85 cm$^2$, and the buttons of each food was 1.7*1.7 cm$^2$.

About color, high contrast colors and plain background color were used. For instance, texts in white color with dark blue background and texts in black color with white background.

Moreover, information was displayed with both picture and text. Multiple sources of feedback (i.e. sound and visual) were given after every action. No scrolling bar was used. Users entered numbers by a numeric keypad instead of a separate keyboard or spin button.
4.2 Qualitative Study

The goals of the first user study were to discover what platform, visual presentation, and functionalities elderly preferred. We performed an interview and questionnaire to gain this information.

4.2.1 Procedure

This study was held in a meeting room in the Philips office in Amsterdam. 8 participants were recruited by using the approach mentioned in Section 3.2. The interview was in English and questionnaire and prototype were in Dutch. During the study, video recordings and notes were made. Before starting the test, participants read the information letter and signed the informed consent form. Firstly, we gave a brief introduction of the project and the procedure of the study. Secondly, the interview started with background questions on hypertension. After that, the prototype was shown on a laptop, an iPad and an iPhone to the participant. The participant interacted with the application on each device. Finally, we asked their opinions on the visual presentation, the functionalities and the platforms.

A digital questionnaire was sent to the participants after the interview, when approved by the Philips ethic board.

4.2.2 Interview Topics

The first section consisted of background questions of hypertension management. Our aim was to have a deeper understanding of the causes of their hypertension, what they have done to manage it, whether they needed more information about hypertension management, and their willingness of adopting new methods and technology to manage hypertension. Hence, the following 6 questions were asked:

1. Do you know what causes your condition?
2. What do you do to manage your hypertension?
3. To what extent do you think healthy lifestyle is important in managing hypertension?
4. Will you be willing to change your diet? Or the things causing your hypertension? How? Why not?
5. Regarding your hypertension, do you have the need for more information? Do you feel that you currently can control your blood pressure sufficiently?
6. Is there anything else that can help you to manage your hypertension?

After we showed the prototype to them, we further asked their opinions on the user interface, the platforms, the willingness and potential benefits of using the application.

1. What do you think about the interface? Why?
2. What do you like or dislike? Why?
3. Visual presentation
   a. Is the layout of texts, images and buttons on the page clear to attract attention?
b. How easy or difficult to read the text? Is the text big enough or too small?
c. How comfortable do you feel about colors on the page?

4. Comprehension
   a. Is there any phrase that you don’t understand its meaning?
   b. Is there any image that you don’t understand its meaning?
   c. Is there any question that is difficult for you to find a response option?

5. Among these platforms, which one do you prefer to use this tool on?
6. What do you like and dislike about these platforms? Why?
7. What do you expect from this kind of application?
8. Would you use it?
9. What is the benefit do you see by using this kind of application?

All interview questions can be found in Appendix B.

4.2.3 Questionnaire

There were two sections in the questionnaire. In the first section, we first asked some demographic questions. Additionally, in order to gain the insights of the lifestyle in terms of blood pressure measuring and diet, the frequency of measuring blood pressure at home and the dietary habit were asked. With this information, we could refine the functionalities and the content in the app to match users’ need. For instance, the frequency of dining out could provide the information of which kind of food should be included to estimate the salt intake. The complete questionnaire is as appendix C.

The 7 questions in this section were:

1. Age
2. Gender
3. Educational level
4. For how long do you have this condition – hypertension (years/months):
5. How often do you measure your blood pressure at home?
6. How often do you eat out?
7. Who does the cooking at home?

The second section was about technology usage. In these questions, it enabled us to understand the average technology literacy and the functionalities they preferred to have in an application. The questions were as the following:

1. Internet use (years):
2. How often do you use Internet?
3. Common mode of Internet access
4. Which of these devices do you have?
5. What do you usually do with mobile device if you have?
6. Please select the functions that you would perform to manage hypertension.
7. Which way will you prefer to enter the food diary?

4.3 Results
4.3.1 Data Analysis

In this part of data analysis, only the questions about the app in the interview were analyzed. The remainder would be combined with the rest two studies and the result will be presented in Chapter 7. This also applied to the data in the questionnaire, we combined the data from the three iterations in order to give a statistics result with a larger sample number. In each iteration, we only displayed the demographic information and the ownership of the devices.

The data gathered in the interview was transcribed by listening through the recordings repeatedly. To reflect the interview questions, the results were clustered by one researcher into three themes by the questions in the interview: user interface (all questions in User Interface Section), platform (all questions in Platform Section) and expectations (question 1 in Application Section).

4.3.2 Participants

We recruited 8 participants but first participant dropped out, so that 7 participants, 4 females and 3 males, took part in this study. Participant A3 did not send back his questionnaire. Five of them were aged from the range of 65 to 69; two were in the range of 70 to 74. All of them had some form of higher education. All of them used Internet at least once a day. Their information was as table 4-1.

<table>
<thead>
<tr>
<th></th>
<th>A1</th>
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<th>A3</th>
<th>A4</th>
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<td>70-74</td>
<td>65-69</td>
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<td>Female</td>
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<td>V</td>
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<tr>
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<td>Tablet</td>
<td>V</td>
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</tr>
<tr>
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<td>--</td>
<td>V</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tablet</td>
<td>V</td>
<td>--</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mobile phone</td>
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<td>V</td>
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<tr>
<td>The frequency of using Internet</td>
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<td></td>
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<td>1 time (day)</td>
<td>V</td>
<td>V</td>
<td>--</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
</tbody>
</table>

*Higher education: HBO, MBO, WO

4.3.3 Results

We categorized their opinions on the prototype into three themes: user interface, platform and expectations.
Theme 1: User Interface

All participants stated that the interface was clear and simple, text was big and color was nice. In addition, it was very easy to understand the phrases and images.

“It’s easy to read, follow, understand. The photo makes it clear” (A2)

About finding a response option, firstly, they suggested that it is better to have a quick method to enter food since people may eat same things every day. Secondly, some participants argued that some foods they eat are not in the list and some foods should have more other options. For instance, brown bread and white bread should be separate and dairy which only had one option as a whole actually has a variety in the type and amount.

“When I use this, it’s the same every day. I have to go through it over and over again” (A1)

“Only for the dairy, is it a glass or mug” (A4)

Theme 2: Platform

Of the three platforms we presented, most people preferred the tablet because it has good mobility and big screen, and it is easy to use and fast. The reason that laptops and mobile phones were less favored was because laptops are slow and the size of a phone screen is small. However, one participant (A3) selected mobile phone because people bring mobile phone with them every day. Also, A1 chose PC because he is used to it.

“There is no much difference. Maybe if you have it (the app) on phone, you have it with you whole day. If you have it on computer, maybe you have it at home later on, maybe you don’t use it. The size of the screen of phone is clear.” (A3)

“I will use the iPad with stylus pen. PC is on the working table. iPad is next to me. iPhone is too small.” (A2)

In the later study, one participant also showed the preference of using such an app on tablets or PC.

“I put it not on my phone, but on my tablet because you have more space... or even on my laptop” (B3)

Theme 3: Expectations

The expectations from users can be classified to three categories: interpretation of the amount of salt intake, the accuracy of the result and suggestions of what to do.
Firstly, given the estimated amount of salt intake, they expressed the need for more information about the result. The interpretation of the number could help them to understand whether the amount of salt is too much or not and also to adjust their diet.

“What I want to know more is it says 2.4 grams but it doesn’t say it’s good or bad. I expect a bit more information.” (A2)

“maybe afterwards it can say there is ... salt in this bread, ... salt in ..., then might be interesting, you may know what to reduce, take out or change” (A2)

Besides the interpretation, the accuracy of the result is also expected.

“I think if it’s really scientific, it’s not just a game. Then I like it” (A6)

“But because of the limitation (the list of food), I doubt about the accuracy. Because I have a different eating habit. I’m almost a vegetarian” (A2)

Finally, they also hope that the application could provide suggestions of what things they can do according to the result.

“I want to know what happens next. So I put all (food) in, and then?” (A1)

“Suggestions are wonderful. Something I can do, I don’t have to follow it.” (A1)

<table>
<thead>
<tr>
<th>Conclusions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. About the user interface, texts, colors, pictures and sentences were clear and fully understandable. The functionality can be more complete by adding (a) more other kind of foods in the list (b) a list of recently added food.</td>
</tr>
<tr>
<td>2. The platform that the participants preferred is tablets.</td>
</tr>
<tr>
<td>3. The expectations from the participants are (a) more information on the salt intake result (b) more accurate result provided (c) suggestions on the subsequent actions they can apply.</td>
</tr>
</tbody>
</table>
Chapter 5

Refined Lo-fi Prototype

5.1 Prototype Design

Based on the results from the first iteration, the prototype was refined. It was also designed using Microsoft Powerpoint 2013.

5.1.1 Functionality

In the findings from previous study, the participants emphasized the importance of comparing the relation of salt intake change and blood pressure. To complete the function of the self-tracking application, the summaries of salt intake and blood pressure measurement were provided. Users can now look up their previously entered data in the application.

Additionally, in the previous study, participants also stated that they had same food every day but still had to go through all the food list with the previous design. Hence, a “Uit de lijst” (select from the favorite list) function was added in the salt intake journal (figure 5-1). It lists the foods that the user has selected before. With this function, users can select the foods from the list instead of going through all the food.

![Figure 5-1. List of favorite food](image)

5.1.2 Application Flow

The application flow was also refined. A list of favorite foods and a main menu were added in order to make it more efficient. It became a two-layer menu, which has the advantages of efficiency and keeping a simple navigation structure. The application flow is shown in figure 5-2.
Figure 5-2. The flow
5.1.3 Visual Presentation

There was one refinement in visual presentation. The progress bar on each page of the salt intake journal was redesigned in order not to be mistaken for buttons. The names of food categories replaced numbers and the shape was modified. Figure 5-3 showed the new design of progress bar.

![Figure 5-3. Progress bar in the second prototype](image)

5.1.4 Information Presentation

The interpretation of the result of salt intake was seen important to users. Hence, in this prototype, more detailed explanations on the amount of salt was introduced. A recommended amount of daily salt intake and the contribution of each food were presented. These are shown in figure 5-4.

![Figure 5-4. Information about salt intake](image)

About the presentation of the summary of measurements, the bar chart was used. As users may not fill in data every day, using a line chart may result in the misinterpretation of data. Moreover, in order to retrieve the exact data by date, the number is shown on the graph. An example of the summary of blood pressure is displayed in figure 5-5.
5.2 Usability Test

In the first usability test, we aimed to evaluate the usability and to gain users’ preference of visual presentation. We conducted a usability test, interview and survey.

5.2.1 Procedure

This study was held in a meeting room in the Philips office in Amsterdam. 5 participants were recruited by the approach mentioned in Section 3.2. The interview was in English and questionnaire and prototype were in Dutch. During the study, video recordings and notes were made. In the beginning of each session, the participant read the information letter and signed the informed consent form. After that, we gave a short introduction on the project and the test. Before the test started, we informed them that we would be using the video recordings. In the test, the participants were asked to complete 4 tasks (plus 3 sub tasks). When the participants stuck in a task or asked questions, we first gave a hint to help them to explore and continue the task. When needed, an explicit hint about what to do was provided. After the test, we held an interview to ask questions about hypertension management and their experience with the application. Finally, they filled in a paper questionnaire, which included background questions and technology use questions.

5.2.2 Task Design

The four tasks were described as the following scenarios:

1-1. You had four slices of bread, two slices of cheese and one cup of milk as breakfast. Now you are going to add them in the salt intake application.

1-1(2). The salt intake results

A. How much salt did you take?
B. What was the biggest contributor?
1-2. You just measured your blood pressure. It is 130/85mmHg. You want to record it in the application.

1-3. You realized that you had some salted nuts after breakfast but you forgot to add it. Now you want to add it.

2. Today you had the same breakfast as yesterday (four slices of bread, two slices of cheese and one cup of milk). Now you are going to add them in the salt intake application.

3. Today you had the same breakfast as yesterday (four slices of bread, two slices of cheese and one cup of milk), but ate two slices of ham more. Now you are going to add the meal in the salt intake application.

4. You want to check your last blood pressure measure. How much was it?

5.2.3 Interview Topics and Questionnaire

Besides those questions listed in section 4.2.2, three questions about usability were added. The questions were selected from the System Usability Scale (SUS) questionnaire (Brooke, 1996). It contained:

1. Was the application easy to use? or unnecessarily complex?
2. Did you find it was effective (not cumbersome) to use this application?
3. How confident did you feel when using this application?

One questions about learnability from the SUS questionnaire was also included in the interview:

1. Do you think you need help from others or need to learn how to use it?

All interview questions can be found in Appendix D.

The questionnaire was the same as the previous study which is in Appendix C.

5.3 Results

5.3.1 Data Analysis

As mentioned in the data analysis in Section 4.3.1, only the questions about the app were analyzed in this result section. The remains would be combined with the other two studies and the result would be presented in Chapter 7.

To analyze the data of the usability test, we watched and transcribed the recording videos to calculate the completion time, evaluate the completion and noted the number of errors. An error was recorded when the participant navigated to the wrong page, clicked the wrong button or asked for help. We used five scales when evaluating the errors. The meanings of each scale were as the following. 0: no errors, 1: few errors, 2: some errors, 3: many errors and 4: fail because of errors.

The data gathered in the interview was transcribed by listening through the recordings repeatedly. To reflect the interview questions, we clustered it into three themes: user interface, usability, learnability and expectations.
5.3.2 Participants

In this iteration, we recruited 5 participants and 5 took part in the study, no dropout. Three were male and two were female. Besides one participant had secondary education, others had higher education. All of them had laptops and mobile phones and used Internet at least once a day. The information was listed in table 5-1.

Table 5-1. Age, gender and education information of the participants

<table>
<thead>
<tr>
<th>Age</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>B4</th>
<th>B5</th>
</tr>
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<tr>
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<td>Mobile phone</td>
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<td>Common mode of using Internet</td>
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<td></td>
<td>1 time (day)</td>
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<td>V</td>
<td>V</td>
<td>V</td>
</tr>
</tbody>
</table>

* Secondary education: VWO; Higher education: HBO, MBO, WO

5.3.3 Usability Test

Figure 5-8 displays the time needed for each participant. We could see that Task 1-1 (add foods) took the longest time, especially compared to Task 2 (add same food) in which they did the similar thing. On the other hand, in Task 1-2 (add blood pressure) needed the shortest time. Compared among participants, participant B2 took longer than the average in all tasks except for in Task 1-3 (add nuts). Participant B5 took the shortest time to complete all the tasks.
Figure 5-8. The time and number of help needed to complete the tasks

Figure 5-9 shows the assessment of errors for each participant. It is noticeable that more errors happened in task 1-1 (add foods), while in task 1-2 (add BP), least errors happened. Among all participants, participant B2 had the most errors to complete tasks while participant B3 only made one error. Table 5-5 displays the time of completion, completeness of the tasks and errors of each participant. Almost all participants were able to complete all tasks. Only in Task1-1(2) (salt intake results), participant B2 and participant B5 were not able to interpret the salt intake results correctly.

From the results above, we found that participant B2 took the longest time and had the most errors. However, there was no big difference in the demographic information and technology literacy among the participants.

The longest time needed and the most errors occurred in task 1-1 (add foods). This might be because it was the first task and the participants needed some time to get familiar with the application. In addition, compared to task 1-2 (add BP) and task 4 (check BP), more steps needed and the flow was more complicated to complete this task.
Figure 5-9. The assessment of errors occurred in each task

Table 5-5. The results of usability test

<table>
<thead>
<tr>
<th></th>
<th>Task1-1 Add foods</th>
<th>Task1-1(2) Salt intake results</th>
<th>Task1-2 Add BP</th>
<th>Task1-3 Add nuts</th>
<th>Task2 Add same foods</th>
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<td>Complete</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td></td>
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<td>4</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>
During the test, we observed and noted some possible refinements to improve the usability. First of all, many participants faced the problem on the flow of selecting all foods followed by entering the amount. The issue was either due to that they did not know how and when to enter it or that they did not understand they needed to click “Meer voedsel” (More food) to go through the whole list when they had selected all the foods. They mentioned these during doing this task:

“Can I put in the number? Or just the product?” (B1)

“I want to fill in this two slices of cheese” (B2)

“And then it must be four (slices of bread), is it possible?” “(Clicked on More food) that is not (where I can enter the amount)” (B3)

“Put them in the meal” “do it four times or? Because I have four slices” (B4)

However, this problem did not appear in Task 2. Hence, the flow of selecting foods and then entering the amount for each food can be improved or a clear instruction should be given before using the application. Secondly, some participants tried to click on the tab in the progress bar to select the category of a food, or click on the picture of food to select the food when entering the amount. This revealed the ambiguity between a clickable button and the information presentation. Thirdly, in Task 2 and 3, we assumed that the participants would choose food from the favorite list. Nevertheless, only one participant did select food from it. When asking them why they did not select favorite list afterwards in the interview, they stated that they did not realize what “Uit de lijst” (from the list) meant. Finally, some participants were confused by the “entering blood pressure” and “blood pressure history” functions. Regarding the interpretation of the result, the participants could understand the chart and result presentation easily.

5.3.4 Interview

After the usability test, the participants shared their opinions on the prototype. Generally, they had positive experiences on using this application.

“Good view on what you eat and how much salt is there. You can quickly change your food. If you see how much salt is in this, then I take something else.” (B3)

“It is an interesting experience to see, for instance, where the most salt is.” (B5)

The followings are the four themes of this part of interview.

Theme 1: User Interface

Most participants stated that the user interface is very clear. The texts were big, pictures were clear, colors were comfortable for eyes and sentences were easy to understand. These feedbacks were
consistent with the findings in the first qualitative study. Participant B5 felt difficult it was to understand the smaller pictures.

“When it became smaller later on, it’s hard to understand. I was focusing on the picture, not the text.” (B5)

In addition, one participant B5 liked the use of bar charts for the summaries of data. However, although the interpretation of “Uit de lijst” (from the list) was not mentioned by the participants, during the test it was noticeable that participants did not select this option as expected. When asking whether any difficulties to select response option, participant B1 answered:

“You can change it to ‘kies uit de lijst’” (B1)

Theme 2: Usability

The usability was evaluated by some questions in the interview. The participants thought the application was easy to use once they got used to it and it was not complex.

“It’s very easy, very clear, not difficult to understand. And once you have done it a few times, I think it got very quickly.” (B4)

Two participants emphasized the importance of using pictures.

“because of the pictures, you can easily see when you have to go to. Make the choice easy.” (B1)

“I was focusing on the picture, not the text.” (B5)

With regard to the efficiency, they also indicated that going through the whole list of food and the two steps of selecting food and entering the amount for each food made the application less efficient, and participant B4 doubted that it would take too much effort.

“I expected I can scroll (the progress bar on the top). but I have to go to all steps.” (B1)

“because you have the step of (entering) meal ... what you eat, and then after this you have to do how much (entering the amounts). Maybe if you can do it in one time, it is shorter to do.” (B3)

“I don’t know is it the idea you do it once a week or every day or meal? I can’t imagine you do it after every meal. It will be a bit of things to do after a meal.” (B4)

Theme 3: Learnability

From the two questions about learnability, most participants stated that they needed a little time to learn how to use it in the beginning but after using it for few times, it was fast and they did not need
help from others. We can also confirm this from the result of time needed to complete Task 2 and Task 3.

“No, I don’t think so (need help or time to learn). I think I can manage this one” (B1)

“Yes in the beginning a little (help or time) to know.” (B3)

“It takes a bit time in the beginning. You don’t need too much help.” (B5)

Participant B4 also suggested to provide an instruction to improve the learnability.

“It’s very quick. I think if you give an instruction, it’s very easy to do.” (B4)

Theme 4: Expectations

When asking about expectations, the opinions can be sorted to three categories: the salt intake estimation functionality, the stability of the application and new functionalities. Participant B1 stated the need for more choices of food in order to compare the salt amount in different foods.

“Maybe it should be more choices if the salt is different, and also the separate picture of the bread. And it’s good to see what gives the most salt. So you can play with it. Trying that will be better for me” (B1)

Three participants suggested to have more functionalities such as alcohol intake and heart beat rate measures journal or to provide suggestions according to the result to furthermore help to change their life style.

“Advice to take less salt, but you can also say that if it’s weekly, a period... also ask to fill in the weight, waist circumference. Maybe it’s possible to give a broad advice.” (B1)

“More function for instance... alcohol intake, the pulse measures, heart beat” (B2)

“I suppose maybe that comes some more afterwards if you enter your BP and the guideline... (about) what to manage...” (B5)

Lastly, the importance of the stability of the application was emphasized.

“(I expect that) it’s working good, not falling out all the time, not stuck. Then that is a really good information” (B3)

Conclusions:

From the usability test
1. During the usability test, the issues that occurred more often were in (a) after selecting a food, how to move to the next step to enter the amount was not clear; (b) misunderstanding the
progress bar as the buttons; (c) the “recently added food list” was not understandable; (d) confusion by the functions of “entering blood pressure” and “blood pressure history”

From the interview
1. In the user interface, two items were seen not easily comprehensible (a) the option of “recently added food list” (b) small pictures.

2. The app was recognized as not complex and the use of pictures made choices easy. However, the two steps of selecting food and entering the amount might reduce the efficiency.

3. About the learnability, help or a little time to learn was needed in the beginning, but after using it a couple of times, it could be handled. Furthermore, the learnability can be improved by a user manual.

4. The expectations from the participants are (a) more foods in the list (b) other self-tracking functionalities (e.g. alcohol intake, heart beat rate measures) and suggestions on the subsequent actions they can apply (c) the app should work stably.
6.1 Prototype Design

6.1.1 Development Tool

To develop the hi-fi prototype application for tablets, the hybrid framework Ionic 1.7.16 was used. Ionic provides tools and services in which designers do not have to take care of Android or iOS core and can develop the application using Javascript, CSS and HTML5. This prototype was developed and tested on ASUS Transformer Pad TF300T (Android 4.2.1, 10.1” screen).

6.1.2 Application Flow

In this iteration, the application flow was also refined according to the observations from the previous usability test. It was evident that many participants wondered where and when to enter the amount after selecting a food, so selecting a food was followed by entering amount in this prototype. A pop-up window appears for users to enter the amount immediately after selecting a food. These two steps are manipulated on the same page, and only one window is activated at the same time which still follows the design guideline (See section 3.3.1). The application flow is shown as figure 6-1.
Figure 6-1. The flow
Besides the main flow of entering food, an exit option “Klaar, ga naar resultaat” (Done, go to the result) was added on every page of the food list which is displayed in figure 6-2. By doing this, users can terminate the process of selecting foods, once they have selected all the foods. This will reduce the unnecessary time waste from going through the whole list.

In the design of the pop-up window of entering amount, a cancel button “Afbreken” (Cancel) was added for error correction. See figure 6-3.

6.1.3 Visual Presentation

From the previous usability test, we found that the progress bar was mistaken for buttons by many participants. Hence, referred to the general design guideline of mobile apps and the design guideline of button size, font size and color use for seniors, the progress bar was replaced by texts “Voedsel Pagina” (Food Page) to show which page it is now. Two buttons on the left and right navigate to the previous page and next page respectively. This is displayed in figure 6-4.

The second modification is the numeric keypad. A button was added to let users be able to correct the number, which is shown in figure 6-3.
6.1.4 Information Presentation

About information presentation, in previous prototypes, descriptions on the buttons were designed as simple as possible. However, some wordings were not easily understood correctly. Since most participants did not understand the meaning of “Uit de lijst” (from the list) as the function of “choosing foods from your list”, we changed it to “Eerder vastgelegd eten toevoegen” (add food which you recorded previously) to make it clearer. Also, some participants were confused by these two functionalities – “Bloeddruk” (blood pressure) and “Bloeddruk Verslag” (blood pressure journal), so verbs were added to describe them. They became: “Bloeddruk ingeven” (record blood pressure) and “Bloeddruk bekijken” (look up blood pressure).

6.2 Usability Test

6.2.1 Procedure

This study was held in a meeting room in the Philips office in Amsterdam. 5 participants were recruited by the approach mentioned in Section 3.2. The interview was in English and questionnaire and prototype were in Dutch. During the study, video recordings and notes were made. A usability test, interview and questionnaire were performed to evaluate the prototype. In the beginning of each session, the participant read the information letter and signed the informed consent form. After that, we gave a short introduction on the project and the test. Before the test started, we informed them that we would be using the video recordings. In the test, the participants were asked to complete 5 tasks (plus 3 sub tasks). When the participants stuck in a task or asked questions, we first gave a hint to help them to explore and continue the task. When needed, an explicit hint about what to do was provided. After the test, we held an interview to ask questions about hypertension management and their experience with the application. Finally, they filled in a paper questionnaire, which included background questions and technology use questions.

6.2.2 Task Design

Tasks in the previous usability test were also used in this iteration. All tasks were described as the following.

1. What did you eat for breakfast today?

2-1. You had four slices of bread, two slices of cheese and one cup of milk as lunch. Now you are going to add them in the application.

2-1(2). The salt intake results

A. From the result, how much salt did you take?
B. From the result, what was the biggest contributor?
2-2. You just measured your blood pressure. It is 130/85mmHg. You want to record it in the application.

2-3. You realized that you had a hand of salted nuts after lunch but you forgot to add it. Now you want to add it.

3. Today you had the same lunch as yesterday (four slices of bread, two slices of cheese and one cup of milk), but ate two slices of ham more. Now you are going to add the meal in the application.

4. You want to add the breakfast you had today in the application.

5. You want to check your blood pressure measurement you entered in the application on 15/juni. How much was it?

Task 4, which was an open scenario, was newly added in order to see how participants operated the application actually without possible influence from the phrasing of the task. Because of task 4, a question in task 1 was asked beforehand to examine whether the foods they selected in task 4 are consistent with the answer.

6.2.3 Interview Topics and Questionnaire

The interview questions and the questionnaire were the same as the previous usability test which can be found in Appendix C and Appendix D.

6.3 Results

6.3.1 Data Analysis

As mentioned in the data analysis in Section 4.3.1, only the questions about the app were analyzed in this result section. The remains would be combined with the other two studies and the result would be presented in Chapter 7.

To analyze the data of the usability test and the interview, we used the same method mentioned in Section 5.3.1.

6.3.2 Participants

In this iteration, we recruited 5 participants and had no dropout. Two were male and three were female. All of them had higher education. About the technology usage, all of them had laptops and mobile phones and used Internet at least once a day. The information was listed in table 6-1.
Table 6-1. Age, gender and education information of the participants

<table>
<thead>
<tr>
<th></th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
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<td>65-69</td>
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<td>Female</td>
</tr>
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<td></td>
<td></td>
<td></td>
</tr>
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<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>Tablet</td>
<td>V</td>
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<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>Mobile phone</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>Common mode of using Internet</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desktop/laptop</td>
<td>V</td>
<td></td>
<td>V</td>
<td>V</td>
<td></td>
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<tr>
<td>Tablet</td>
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<td>V</td>
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<tr>
<td>Mobile phone</td>
<td></td>
<td>V</td>
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<tr>
<td>The frequency of using Internet</td>
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<td>&gt;3 times (day)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1 time (day)</td>
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<td></td>
<td></td>
<td>V</td>
<td>V</td>
</tr>
</tbody>
</table>

* Secondary education: VWO; Higher education: HBO, MBO, WO

6.3.3 Usability Test

Before the usability test began, in the first task, the participants wrote down what they had as breakfast on that day. Table 6-2 lists the results of the usability test.

The results of completion time of each task is as figure 6-5. Among all the tasks, task 2-1 (add foods) took the longest time to complete the task. However, after this task, in task 3 (add the same foods and hams) and task 4 (add own breakfast) where they also entered food into the food journal, it took shorter time than the first task. The completion time of C2 in task 4 was not counted because he only had coffee as breakfast which was not in the food list. Task 2-1(2) tested whether the participants could interpret the salt intake result. C2 could not distinguish what was the biggest contributor from the visual presentation and C4 could not see the pictures clearly and tried to zoom in the pictures.

On the other hand, in task 2-2 and task 5, participants entered the blood pressure measurements and check the history data respectively. These relatively short tasks yielded the shortest completion time. Compared across the participants, it was clear that C1 took longer than the average time in most tasks.
About the errors shown in figure 6-6, we could see that errors occurred the most in task 2-1(add foods) and task 2-1(2)(salt intake results), and task 2-2(add BP) and task 5(check BP) had the least errors. C1 made more errors and she constantly asked whether she did correct. C2 and C4 could not complete task 2-1(2) so explanation of the result of salt intake was given, and 2 participants faced difficulties to recognize the small picture of food.

In sum, task 2-1(add foods) took the longest time and more errors happened during this task, this might be because the participants were unfamiliar with the application in the beginning. Furthermore, in this task, participants were required to select foods and enter the amounts of each food. The long task and the complicated process increased the completion time and errors. By contrast, shorter and simpler tasks, task 2-2(add BP) and task 5(check BP), took the shortest time and less errors occurred.
Finally, we observed and noted some issues when they interacted with the application. In the food journal, the first issue was that the participants could not understand the options of “Eerder vastgelegd eten toevoegen” (add food which you recorded previously) and “Ander eten toevoegen” (add other foods). The second issue that occurred often was that the participants did not realize that there were 6 pages of food so they could not find the food they wanted to choose. It turned out that some form of help was needed to have them navigate to the next pages. Sometimes, indication to finish food entry and go to the result page was also needed. When selecting food and entering the amount, some participants clicked on the number under the food picture which was not a clickable button. When using the numeric keypad, 2 participants needed assistance to know how to correct the wrong number input. In the result of salt intake, 2 participants mentioned that the pictures were
too small to recognize and one participant pointed out that the picture of “bread” shown in the result page was different from what she chose so she was confused.

6.3.4 Interview

In the interview about the application, we categorized it into four themes: user interface, usability, learnability and expectations. In general, participants thought the application was complicated in the beginning but they could figure out how it worked from practicing the tasks. Moreover, they considered the functionality of salt intake was important and helpful. By using that, people could know the salt amount and change the diet.

Theme 1: User Interface

For all participants, the text style and size were recognized big and easy to read. They also stated that the colors are clear, and simple but fine. About the use of pictures, most participants reported it was clear, but one participant thought it was a bit childish. Moreover, it was more difficult to recognize the smaller pictures shown in the salt result page for some participants.

“I thought it was nuts, but it was bread? (in the result page)” (C1)

Participant C3 indicated that the pictures in the salt result page were not consistent with the pictures in the food list. She was confused by the pictures when interpreting the result.

“It (the biggest contributor) was luxury bread, it was 1.6 g, that must be the worst thing (for blood pressure). But I put down slices (of bread), not luxury (bread).” (C3)

With regard to the comprehension of sentences, two participants mentioned that “systolische” (systolic) and “diastolische” (diastolic) were rarely used in Dutch. Fortunately, with the extra explanation of “bovendruk” (upper pressure) and “onderdruk” (lower pressure), they were able to understand it.

“It is good that you made a translation (explanation) of systolische and diastolische... People only know upper pressure and under pressure not systolische and diastolische.” (C1)

Finally, the descriptions (Eerder vastgelegd eten toevoegen; Ander eten toevoegen) for “add from favorite or recently eaten food” and “add other foods” were not understood by the participants, even though it was refined by adding more details from previous prototype. This resulted in either the wrong selection or taking more time to make the decision.
Theme 2: Usability

Most participants described the application as not being complex once you got used to it, but at the beginning, it did take time to figure out how it worked. Two participants C4 and C5 also suggested to provide instruction especially for seniors.

“It’s complicated. I think for others, more elderly it’s too complicated.” (C1)

“No not complicated, once you’ve done it it’s simple” (C2)

“When you know it, it’s easy. But first time is hard” (C3)

“It is complex now, but after some playing with it, it might be easy. My age is counting so my first opinion is (this app is) difficult” (C4)

“It’s simple, only takes a few minutes to get to something, have to find out first.” (C5)

Most participants felt it was effective to use and it was useful that it immediately showed how much salt there was in food after entering food data.

“I like... you can see how much salt, and if you change the amount or other choice you can see what changes” (C5)

Nevertheless, not many participants felt confident using the application. This was also discovered during the test. Two participants, C1 and C5, frequently asked to confirm whether their actions were correct or not before they took action.

“Not so much confidence” (C3)

Theme 3: Learnability

Most participants stated that they needed time to learn and other’s help in the beginning, and the suggestion of providing an instruction was mentioned.

“No, I don’t think I need a long time to learn it. But in the beginning without the help I would have gone lost.” (C3)

“First, help going through it together, then doing it by myself” (C4)

“Older people should get an instruction” (C5)

Theme 4: Expectations

About the expectations of the application, many participants stated that more foods should be added to make the food list more complete. In addition, other functionalities relevant to health and hypertension such as exercise recording and medication intake could be included in the application.
“I get results, and helps with decisions of what I can or can’t have. But I really need more pictures (food types). I didn’t see the cereals, grains, modern foods...” (C1)

“I would like other functionalities, like sports, medical history, other things that cause hypertension” (C2)

Finally, participant C4 suggested that the app should be more attractive to the target users by adding other features such as games.

“It better if it would be more like a game. Make the app attractive to users” (C4)

Conclusions:

From the usability test
1. The major issue was that participants could not differentiate the options of “Eerder vastgelegd eten toevoegen” (add food which you recorded previously) and “Ander eten toevoegen” (add other foods).

2. Other minor issues were: (a) participants did not notice the buttons to go to next pages of food; (b) participants needed assists on going to the result; (c) the “correct” button in the numeric keypad was not obvious; (d) participants clicked on the number when selecting a food; (e) the inconsistency of picture use.

From the interview
1. For user interface design, we found (a) small pictures should be avoided; (b) when translating into other languages, it is best to consult native speakers about what are the common used terms (i.e. upper pressure, lower pressure).

2. The participants stated that they felt that this app was complicated to use in the beginning. Some of them were not confident using it. However, they thought it was efficient.

3. About the learnability, they stated they needed help and time to learn in the beginning. An instruction might help especially for seniors.

4. The expectations from the participants were (a) more food in the list; (b) other functionalities relevant to hypertension control (e.g. exercise, medication); (c) the design can be more attractive to the target users.

Finally, table 6-3 lists the summary of the objectives, findings and prototype design of the three iterations.
Table 6-3. Summary of three iterations

<table>
<thead>
<tr>
<th></th>
<th>Iteration 1</th>
<th>Iteration 2</th>
<th>Iteration 3</th>
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<td><strong>Objectives</strong></td>
<td>1. Functionality</td>
<td>1. Application flow</td>
<td>1. Application flow</td>
</tr>
<tr>
<td><strong>Findings &amp; usability issues</strong></td>
<td>1. Favorite list, summaries of salt intake and blood pressure measurement were needed</td>
<td>1. Confused with 2-step flow of selecting foods and entering amounts</td>
<td>1. Difficulty to find the button to the next page of food</td>
</tr>
<tr>
<td></td>
<td>2. Tablet</td>
<td>2. Ambiguity in buttons and progress bar, more salt intake information presentation was needed</td>
<td>2. un-readable small pictures, inconsistency in pictures</td>
</tr>
<tr>
<td></td>
<td>3. Ambiguity in buttons and progress bar, more salt intake information presentation was needed</td>
<td>3. Confusion with “enter blood pressure” and “check blood pressure history”; the wording of the button “Uit de lijst” (from the list)</td>
<td>3. Hard to understand the meaning of “Eerder vastgelegd eten toevoegen” (add previously recorded food)</td>
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<td><strong>Functionality</strong></td>
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<td>1. Salt intake diary</td>
<td>1. Summaries of salt intake</td>
<td>--</td>
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<tr>
<td></td>
<td>2. Blood pressure tracking</td>
<td>2. Summaries of blood pressure</td>
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<td><strong>Visual presentation</strong></td>
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<td>1. Progress bar</td>
<td>1. Modified progress bar</td>
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<td></td>
<td>3. High contrast colors with plain background</td>
<td>3. The amount of selected food</td>
<td>3. The amount of selected food</td>
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<td>4. Larger button size</td>
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<td><strong>Application flow</strong></td>
<td><strong>Application flow</strong></td>
</tr>
<tr>
<td></td>
<td>1. Pro-active chatting wizard</td>
<td>1. Main menu</td>
<td>1. One step of selecting food and entering the amount</td>
</tr>
<tr>
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<td>2. One level navigation</td>
<td>2. List of favorite food</td>
<td>2. Exit button</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Back and home buttons</td>
<td>3. Error correction</td>
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<td><strong>Information presentation</strong></td>
<td><strong>Information presentation</strong></td>
</tr>
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<td></td>
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<td>1. More information on the start page</td>
<td>1. Wording of button and functionalities</td>
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<td>2. Information about the result of salt intake</td>
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<tr>
<td></td>
<td></td>
<td>3. Showed the amount of salt for each food</td>
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Chapter 7

Experience on Hypertension Control and Attitude towards the Health Self-management Tool

7.1 Introduction

In Chapter 4, 5, and 6, we analyzed the data from the interview and questionnaire regarding participants’ opinions on the app design. In this chapter, we integrated and analyzed the data about (1) the seniors’ experience on hypertension management; (2) their willingness to adopt the health self-management tool; (3) habit of diet and blood pressure measuring; (4) technology usage from the interviews and the questionnaires in three iterations. The related questions are listed in Section 7.2, and the results are presented in Section 7.3.

7.2 Interview and Questionnaire

7.2.1 Interview

The background questions of hypertension management were:

1. Do you know what causes your condition?
2. What do you do to manage your hypertension?
3. To what extent do you think healthy lifestyle is important in managing hypertension?
4. Will you be willing to change your diet? Or the things causing your hypertension? How? Why not?
5. Regarding your hypertension, do you have the need for more information? Do you feel that you currently can control your blood pressure sufficiently?
6. Is there anything else that can help you to manage your hypertension?

Questions about their willingness and potential benefits of using the application were:

1. Would you use it?
2. What is the benefit do you see by using this kind of application?

7.2.2 Questionnaire

The questions about habit on diet and blood pressure measuring were:

1. For how long do you have this condition – hypertension (years/months):
2. How often do you measure your blood pressure at home?
3. How often do you eat out?
4. Who does the cooking at home?

The questions about technology usage were:

1. Internet use (years):
2. How often do you use Internet?
3. Common mode of Internet access
4. Which of these devices do you have?
5. What do you usually do with mobile device if you have?
6. Please select the functions that you would perform to manage hypertension.
7. Which way will you prefer to enter the food diary?

7.3 Results

7.3.1 Data Analysis

Thematic analysis was used to find the themes and interpret the results from the interview. First of all, the interviews were transcribed by listening through the recordings repeatedly. Secondly, the important and frequent terms were extracted by reviewing the transcription with both inductive (data-driven) and deductive (question-driven) methods. Thirdly, from those codes, we looked for potential themes by combining codes. The five themes and the codes are listed in Appendix E. Finally, we reviewed the themes to check whether the codes matched each theme and answered our questions.

7.3.2 Interview

From the first part of each interview, we classified the results into five themes:

1. Current approaches of hypertension management including the causes of the condition
2. Information obtained and needed
3. Adoption of new approaches to manage hypertension
4. Willingness of adopting this application
5. Benefits from using this application.

Theme 1: Current Approaches of Hypertension Management Including the Causes of the Condition

The first theme refers to the methods that the participants normally use to control their hypertension. We realized that most participants considered obesity, genetics and age as the causes of their hypertension.

“The doctor said I’m overweight” (A2)

“My age. I didn’t change anything in my lifestyle. It was good before. Now suddenly I have hypertension.” (C1)

“Family matter, my father had it, died of it” (C2)

In addition, stress was also mentioned by one participant as the cause of hypertension.
“I think it’s family related. With stress it is getting higher” (A7)

Most of the participants controlled blood pressure by taking medication. However, three participants didn’t feel well when taking medicine, so they preferred to use non-pharmacological approaches such as exercise and losing weights to control it.

“But that (medicine) made me dizzy. I don’t stay medication... So I’d better lose weight and take diet. It lasts till now. Then I think why I should take it (medicine) if I can do that in other way. It (my blood pressure) was not extremely high” (A6)

“I choose not to use medicine. Then I try to lose weight. Then it’s better” (A3)

Other common ways were doing exercise, losing weight and adopting a healthy diet. They were aware that keeping active and staying fit are important. Many of them have realized that salt and alcohol intake influenced blood pressure level so they added salt as little as possible in meals. Weight and waist circumference were also seen as the indicators of health.

“Then I choose not to use medicine. Then I try to lose weight. Then it’s better” (A3)

“I move (exercise) a lot. I think that’s important and I do lots with food. I don’t eat too much salt.” (A7)

“I’m very focused on salt and fat, low alcohol, and normally one glass of wine per day but not every day. I try to walk outside or go to the gym. I measure my weight and sometimes I measure waist circumference.” (B1)

“I get medicine. I walk and cycle” (C2)

Finally, in the third study, two participants C3 and C4 believed that smoking would have impact on blood pressure. However, one participant still cannot stop smoking.

“My only sin is smoking. I believe the fantasy that I can control the salt, but the effect of the good food is thrown away by my smoking....it’s also what you still want in life” (C3)

“6 years ago hypertension was diagnosed, the smoking was of influence I think” (C4)

With regard to diet, they avoided eating too much salt, greasy meat, precooked food, and sweets. Instead, they cooked fresh foods, ate biological food, added spices to replace salt and looked for alternatives for foods with high amount of salt. One participants A3 found that when she only ate during regular meals time, and did not eat other snacks, she could control the blood pressure better.

“Avoid salt, all the healthy things, I skip meat because it’s not healthy to eat much meat” (A6)

“I also noticed that when I take less extra things (snacks), my blood pressure is going down” (A3)
When asked whether they kept a food journal or not, none of the participants did. Some participants stated that they knew what they ate, which food was good and which was bad. Therefore they did not record it.

“Because you know what you eat. You knew it when you did it wrong” (A3)

“I know exactly if it is good or not. I don’t have to write it down” (A7)

The other reason was that they thought they already had healthy diet and it did not need to be recorded. Participants mentioned that they were already used to avoiding salt:

“You have to get used to cook potato not using any salt. After some time, you will get used to it” (A6)

“No, in my food, I use salt as less as possible. Only sometimes a little bit sea salt.” (B2)

Also, one participant stated that he had succeeded in losing weight by diet control without recording it. Hence, he did not consider food journal important.

“No, never recorded my food. I don’t see the importance. My goal was to reduce weight and I did well without recording it.” (C2)

Finally, one participant mentioned that they ate similar food every day so she did not need to keep the food journal.

“I eat same thing like breakfast is always the same” (C3)

The last approach to manage hypertension is tracking blood pressure. No matter whether they measured the blood pressure at home or not, the equipment seemed to be an obstacle for them. One participant stated that his doctor did not trust the results from the blood pressure meter at home.

“Some doctors said I don’t believe the result is correct. Of course I take BP three time, not only one time (per day). You see the different moment in the day. Sometimes low, sometimes higher.” (B2)

Three participants did not know whether they manipulated the meter correctly or felt it was complicated and expensive.

“Because I don’t know if I do it correctly or not. I don’t know if the number is right. I don’t know where to put this, put that...too complicated to me.” (A6)

“No, (I didn’t track my blood pressure). I have a machine at home but it doesn’t work properly. Sometimes it goes in stress mode. Yes it goes way over to 200 then next time it is 230. Also the band doesn’t close sometimes.” (B5)
“Measuring the blood pressure (at home), the device is expensive (and) doing it is complicated.” (C1)

For the participants who did not measure blood pressure at home, one reason they gave was that knowing their blood pressure may worry them more.

“I know sometimes it goes up. When I go to the doctor I measure it. I don’t want to know myself” (A2)

“I’m so tired to do that and start to worry” (A2)

The other participant pointed out that she did not know how to improve the blood pressure even though she measured it:

“What can I do with the results? I have my medication that will help I hope. I don’t know how to lower it (the blood pressure)” (C1)

For the participants who did have a blood pressure meter at home, most of them did not measure it regularly and did not record it. However, participant A7 wrote it down on paper and brought it when going to the doctor. Participant B2 recorded his blood pressure measurement on PC and took his blood pressure and heart beat rate measurements to the interview. Another participant C3 measured 3 times a day and recorded it on paper.

“Yes, and when I go to the doctor, I take it (blood pressure measurements) with me.” (A7)

“There is a computer software. I put them (blood pressure measurements) on the computer. Before I go to the doctor, I sent (it to the doctor).” (B2)

“I measure blood pressure 3 times a day. (I’m a nurse) I record it on paper. I tried an Iphone recording, but went back to paper. (Couldn’t find handy app)” (C3)

Participant A5 measured his blood pressure and took that as an indicator of whether he needed to go to the doctor or not.

“I know when it (the blood pressure) was bad last time, then I did that (measuring blood pressure) 2 days later. If that happens a couple of times, then I go to the doctor.” (A5)

One participant kept tracking her blood pressure because she knew there was a risk of brain diseases.

“You can have more damage in your brain. That is also why I control my blood pressure. I’m afraid of brain bleeding and Alzheimer. And once the doctor told me I’m at risk.” (C3)

When talking about why they did not record these measurements, the most common reason was that those measurements were stable through time.
“That (my blood pressure) is about the same range. I know if this (waist circumference) is going more, I know I have to make more exercise.” (B1)

“I do measure blood pressure at home, once a week. I don’t record it, I know what it normally is. I remember it” (C2)

“No, it (my blood pressure) is quite stable. I’m neglective. If the doctor says I need to do it or don’t do it, I will try to.” (C4)

However, one participant also mentioned that he may be more willing to record it by using this kind of application.

“No. but if it’s in the application like it. Then I think it’s handy. You have place to record it. And otherwise it will be a piece of paper and next week it’s going away.” (B1)

**Conclusions:**
1. As said by the participants, the causes of hypertension are (a) obesity (b) genetics and (c) age. Additionally, multiple chronic diseases and stress are also seen as the causes.

2. Common approaches to control hypertension are (a) medication (b) exercise (c) losing weights and (d) healthy diet (e.g. salt and alcohol intake).

3. Smoking was also seen as a factor influencing the blood pressure.

**Diet tracking**
1. Regarding diet tracking, none of the participants kept a food journal.

2. The reasons for not keeping a food journal are (a) they knew what they ate, what food is good and what food is bad; (b) they already used salt as little as possible and did not think it could be improved anymore; (c) were experience and confidence with diet control without the food journal; (d) they eat the same thing every day.

**Blood pressure tracking**
1. Regarding blood pressure tracking, most participants did not measure blood pressure at home.  
   1.1. The reasons for not measuring blood pressure at home were (a) did not have a meter at home; (b) they or their doctors did not trust the meter; (c) the meter was expensive and complicated to use; (d) did not want to worry about their condition because of the blood pressure measurements; (e) did not know what to do to lower the blood pressure if the blood pressure measurement was high.

2. Some participants measured blood pressure at home, but few of them did it regularly and record it.
   
   2.1. They took the blood pressure measures (1) as an indicator of whether or not to see the doctor; (2) to prevent severe consequence from happening.

   2.2. For the participants who did not record it, the reason were (1) the blood pressure level was stable; (2) they remembered it; (3) the data could be saved on the blood pressure meter.
2.3. For the participants who recorded, they used pen and paper. However, they also showed an interest in using an app to record it because the data could be kept better.

3. Technology seems to be an obstacle, because (1) doctors did not trust the measurements at home; (2) they were not sure whether they manipulated the device correctly or felt it was complicated and expensive.

**Theme 2: Information Obtained and Needed**

The second theme is the information they needed and how they obtained it. The information about hypertension was mainly gained from professionals such as doctors, hospitals and dietitians.

“*I had also a dietitian... a person that tells you what to eat*” (A3)

“I get help for 13 years already, my doctor told me everything I need to know” (C2)

“*Get information from doctors*” (B2)

Nevertheless, three participants also mentioned that doctors did not always provide the information about the influence of salt intake on blood pressure.

“*the doctor says you just take the pill*” (A5)

“Especially if the doctor says you have to do salt intake. They (doctors) don’t always do. My doctor never said” (B5)

“I didn’t change my food and salt after begin diagnosed with hypertension. I got medication. Doctor didn’t tell me to change my food.” (C1)

They also looked up information on Internet and the nutritional information shown on the package of food.

“I can look it up on the internet” (A5)

“If I need something I also look on Internet” (C5)

“I looked at that (information) on the package, if I saw another one is less (salt), then I take that one.” (A3)

“When I go shopping I saw the package every time” (B2)

In addition, the blood pressure measurements were considered as the most important form of information in controlling hypertension.

“*Not really, (I don’t need more information) I have the meter at home*” (A1)
"What I have to do is to have it (hypertension) checked...." (A6)

However, they did have concerns about the reliability of blood pressure meters and wondered how to interpret the number.

“The information about how the equipment is reliable. Mostly important thing is to interpret the number. 90/xx what does this mean? Have to do something more or not to do something?” (A4)

As a result, since they were already obtaining information through different ways and as long as they were not bothered by the current condition, they did not see the need for more information, but were open to receive new information.

“If more things affect blood pressure, it’s good to know.” (B1)

“I don’t know. Maybe when there is new information. When you know new things, it’s always good to follow” (B3)

However, two participants were afraid that he/she would worry more about the hypertension more if he/she knew more information.

“Sometimes I think I’ll buy a blood pressure meter. I’m so tired to do that (measure blood pressure) and start to worry” (A2)

“No. That makes me worry too much.” (B5)

Conclusions:
1. People obtain information from (a) professionals (b) searching on the Internet (c) nutritional information on the package of food.

2. The blood pressure measurements were considered as an important form of information in controlling hypertension, while the reliability of blood pressure meters and how to interpret the number were their concerns.

3. Most participants did not see the need for more information because (a) through different ways they can obtain the information; (b) as long as they were not bothered by their condition; (c) being afraid of worrying more when knowing more. However, some are open to receive new information.

Theme 3: Adoption of New Methods to Manage Hypertension

The third theme is the adoption of other methods to control hypertension, especially focusing on food journal and technology. Most of the participants responded that they had not thought about
other hypertension management methods. Because they considered themselves living a healthy lifestyle.

“Of course (I am willing to change my diet), but I don’t know how. I never add any salt. I eat very healthy” (A5)

“My diet can’t be better. That’s the stress. I do fitness two hours three times a week. So what else can I do?” (A7)

However, four participants mentioned that they would be willing to change diet if the doctor would ask, and one participant A6 said she would change diet if she could see the actual effect.

“My dietician and doctor make the decision (of whether to change my diet or not)” (A4)

“Yes probably. Especially if the doctor says you have to do salt intake (monitoring)” (B5)

“If the doctor says I need to do it, or don’t do it, I will try to” (C4)

“You change your diet or lifestyle if you have confidence that it will help you... If there is something easy to check it myself, that will help to see whether my diet works” (A6)

They realized that dealing with food and doing exercise could help them to manage hypertension better and avoid taking more medicine.

“Food, exercise, and using alcohol as less as possible” (B2)

“I think it’s wise to change the way you prepare the meals than going to medicine. I mean I’d rather do with food than taking extra medicine or whatever.” (B4)

Moreover, two participants addressed the importance of reducing stress and nervousness in hypertension control and it would be helpful to check the influence of stress and nervousness on blood pressure.

“It could also check if you are very nervous, stressful to see if it causes hypertension” (A6)

“What I mentioned was not to fill in my days with so many things... To go outside or to the sea that’s also making things empty (to relieve stress).” (B3)

Regarding using technology to facilitate blood pressure control, two participants, A1 and A7, expressed that they did not have a smart phone.

“No, I even don’t have a smart phone. My telephone does everything I want. I don’t need (a smart phone). I have a PC. That is enough for me.” (A1)

“I only have a blood pressure measure machine. I don’t use a smartphone” (A7)

For other participants, because either they were still new to using a smart phone or it was difficult to use new technology, they never thought about using an app to track their blood pressure.
“also ipad broke down, pc broke down, iphone is not working. So I’m very scared of using more and more apps” (A2)

“No, I rarely do things with apps. I’d rather use my machine (PC).” (A5)

“No, I don’t know how.” (A6)

“No, my mobile phone ... before it was only a phone. Now it’s a smart phone... I don’t make the time to do that...” (B1)

One participant had a pedometer App on phone, but never used it. She pointed out that it may need some time to have it as a habit.

“Too lazy. Maybe, I feel myself good so no needs.... Maybe have to make a habit of it... So if you see you didn’t walk much that day, then you can think I have to do half an hour in the home trainer” (A3)

The other reason was that they did not know these applications existed.

“Maybe I don’t know what application would be good for me, or I cannot find it.” (B1)

“No, I didn’t know it exists.” (B4)

“No, are there other applications? I don’t know them. I go to internet, but never look for medical things or BP.” (C4)

One participant stated that doctors can suggest this kind of self-health management tool to patients.

“Dietitian, that sort of thing they can tell you .. patients to use this. And you can just do it at home, and check it yourself what you are doing. And even doctor.. they can just tell you about the app which you can do it yourself.” (B4)

**Conclusions:**

1. Most of the participants considered themselves living a healthy lifestyle, hence they could not think of a way to change diet for the better.

2. Some participants would adjust their diet, do more exercise and change lifestyle to manage stress better to control their blood pressure and avoid taking more medication.

3. Most of the participant never thought about using technology to help them in hypertension control. Some reasons are (a) new users of smart phone or not using apps much (b) the unreliability of technology (c) having to make the habit of self-tracking (d) did not know the apps existed.

4. Some participants would adjust their diet if their doctors asked; professionals could suggest this kind of app to patients.
Theme 4: Willingness of Adopting This Application

For those participant who were motivated to use this app, one important reason was to avoid using medication.

“Because I don’t like to go to the doctor. Only (when) it is necessary. This is easy. But this program now only gives you how much salt you use, but is it advising also after that?” (A6)

“I would use it yes. I don’t like using medicine. I’m already busy lowering the salt.” (C3)

The other reason was that they realized that having less salt would help to control hypertension. Hence, by using this app, they could monitor their salt intake and check the relation between salt intake and blood pressure.

“I have checked what causes hypertension…. A lot of article have said salt is the main cause” (A2)

Also, it was not difficult and handy for them to use the application and it was helpful.

“No difficulty. It’s very clear” (A3)

“Might be (using it)... this (app) is quite manageable for me” (A5)

“Yes I think so. Mobile phone and simple to fill in. I use a mobile phone and a desktop. It’s easy to get your phone and fill in what you eat. Not going back to desktop to fill in.” (B1)

“It’s very handy. Because I have something to measure my blood pressure. You can also see it back on the machine, but not so long (only has a small number of records)... But (in this app) you have immediately also the relation between the food and the blood pressure” (B3)

There were two main reasons of not using the application: they already live a very healthy life and they do not use apps much.

“This is still extra for me. I have an application about health, but I never use it…. I don’t do anything with app” (A5)

“I eat healthy, I live healthy...I feel very fit and good. So I don’t have any reason to look for my health” (A5)

“No, because I already know everything” (A7)

“If the blood pressure is normal, I imagine I’m eating alright, I’m eating the right thing, so to keep tracking it all the time, I don’t really see the point.” (B4)

Two participants also expressed their hesitations. They thought it needed too much work to do it every day.

“Maybe, the only thing is that’s a lot of work” (B2)
“(laughter) maybe. It’s lot of work every day, every meal. Too much work” (B5)

Participants C1 addressed that the food list should be more complete, and two participants, C2 and C5, stated that they would only use the application if they wanted to know the salt information about certain foods.

“I might use it. Yes, maybe… it should be easier and more complete, more pictures (more foods)” (C1)

“Yes but I wouldn’t use it daily, regularly. I don’t think I would eat differently when I would use it. I only would use it when I had a complete different food intake.” (C2)

“Yes, maybe I also would like to show to other people. I would not use it every week, I eat similar every day. I think I would use once in a while, in the beginning more to learn what contributes most.” (C5)

**Conclusion:**

1. The reasons of being willing to use the application are (a) avoid taking more medication, (b) realized having less salt helps to control hypertension and (c) easy to use.

2. The reasons of not being willing to use the application are (a) already living a very healthy life (b) not using apps (smart phone) much and (c) it takes too much work to enter each meal.

3. The willingness of using it will increase (a) if the list of foods is more complete (b) when having certain needs such as learning knowledge about the amounts of salt in foods.

**Theme 5: Benefit**

Three main benefits were mentioned. The first benefit was that the application would be able to make people aware of their diet and health problems.

“That makes me aware of what I’m eating actually” (A1)

“If you write it down, or use the application, it is more confronting” (A3)

The second benefit was that it could track the blood pressure with the change of salt intake and further help people to adjust their diet based on it.

“It helps you to change your eating habit. So if I see like this this and this (different amount of salt in different food), I can change and see if the quantity of salt is lower and the blood pressure is as well” (A6)

The third one was gaining more knowledge on the amount of salt in foods. This would make them more aware of which food has more salt or which food has less, and helps them to have a healthier choice of food.
“Because it tells you which has more salt, which has less salt. So you can play around with it, and sort of find out the diet. What is best to eat.” (B4)

“I didn’t know that bread has so much salt. So that’s interesting.” (B5)

“I will get more knowledge which gives help in controlling blood pressure better” (C3)

For the participants who cannot see the benefit, they argued that young or fat people may be able to benefit from it more.

“Not for me. Maybe for younger people who do everything with apps” (A5)

“I see so many fat people, I think that will help them. Because... I dropped several kilos, only by working with food” (A7)

“It should be targeted to people 50-60 years old, younger. Not for me” (C4)

### Conclusion:

1. Three main benefits are (a) being aware of their diet and health problems (b) tracking the relation of blood pressure and salt intake and adjusting diet based on it, and (c) gaining more knowledge on the amount of salt in foods.

2. Younger or fat people may benefit more.

### 7.3.3 Questionnaire

One participant in the first study did not send back the questionnaire, so that we had totally 16 completed questionnaires from three studies. 69% of them were aged in the range of 65 to 69 and the numbers of males and females were the same. One participant had secondary education; the rest had higher education.

In the question about measuring blood pressure at home, 44% of the participants did not measure blood pressure at home and 19% of them measured it every day. Others measured it either weekly, irregularly or once in a while. Regarding their diet habit, it showed that the frequency of going out for dinner was mostly one time or less per month. Cooking at home was done either by themselves or their partners. The results are listed in table 7-1.

Second part of the questionnaire was about their technology usage and the functions in the application they may need to control their hypertension.

Table 7-2 displayed the results of the technology usage. All participants used Internet at least once a day and half of them used it at least 3 times per day. Almost all of them had both a computer and mobile phone and they use Internet on computer mostly. The functionalities they usually used on mobile devices were making phone calls, searching for information, receiving emails, and taking pictures.
Table 7-1. Characteristics of the participants and their habit of diet and blood pressure measuring

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Number (n=16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>age</td>
<td></td>
</tr>
<tr>
<td>65-69</td>
<td>11 (69%)</td>
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<tr>
<td>70-74</td>
<td>3 (19%)</td>
</tr>
<tr>
<td>75-79</td>
<td>2 (12%)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>8 (50%)</td>
</tr>
<tr>
<td>Female</td>
<td>8 (50%)</td>
</tr>
<tr>
<td>Education level</td>
<td></td>
</tr>
<tr>
<td>Secondary education</td>
<td>15 (94%)</td>
</tr>
<tr>
<td>Middle school</td>
<td>1 (6%)</td>
</tr>
<tr>
<td>How long they have had hypertension</td>
<td></td>
</tr>
<tr>
<td>(n=15)</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>6.74 year</td>
</tr>
<tr>
<td>Range</td>
<td>3 month - 17 year</td>
</tr>
<tr>
<td>Frequency of measuring blood pressure</td>
<td></td>
</tr>
<tr>
<td>at home</td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>7 (44%)</td>
</tr>
<tr>
<td>Daily</td>
<td>3 (19%)</td>
</tr>
<tr>
<td>Weekly</td>
<td>3 (19%)</td>
</tr>
<tr>
<td>Others</td>
<td>3 (19%)</td>
</tr>
<tr>
<td>Frequency of eating out</td>
<td></td>
</tr>
<tr>
<td>Monthly or less</td>
<td>14 (88%)</td>
</tr>
<tr>
<td>3-5 times / week</td>
<td>1 (6%)</td>
</tr>
<tr>
<td>1-2 times / week</td>
<td>1 (6%)</td>
</tr>
<tr>
<td>Who does cooking at home</td>
<td></td>
</tr>
<tr>
<td>Myself</td>
<td>10 (63%)</td>
</tr>
<tr>
<td>Partner and self</td>
<td>3 (19%)</td>
</tr>
<tr>
<td>Wife</td>
<td>2 (13%)</td>
</tr>
<tr>
<td>Friend and self</td>
<td>1 (6%)</td>
</tr>
</tbody>
</table>

Table 7-2. Technology usage

<table>
<thead>
<tr>
<th>Technology usage</th>
<th>Number (n=16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency of using internet</td>
<td></td>
</tr>
<tr>
<td>Daily</td>
<td>8</td>
</tr>
<tr>
<td>3 times / day</td>
<td>8</td>
</tr>
<tr>
<td>Common mode of Internet assess</td>
<td></td>
</tr>
<tr>
<td>Desktop / laptop</td>
<td>11</td>
</tr>
<tr>
<td>Mobile phone</td>
<td>5</td>
</tr>
<tr>
<td>Tablet</td>
<td>3</td>
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<tr>
<td>Desktop / laptop</td>
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<td>Tablet</td>
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<tr>
<td>Usage on mobile devices</td>
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<td>Calls</td>
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<td>Search for information</td>
<td>10</td>
</tr>
<tr>
<td>Receive emails</td>
<td>9</td>
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<tr>
<td>Take pictures</td>
<td>9</td>
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<tr>
<td>Read news</td>
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<td>Alarm</td>
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</tr>
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<td>Watch time</td>
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<td>Listen to music</td>
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<td>Watch videos</td>
<td>1</td>
</tr>
<tr>
<td>Play games</td>
<td>1</td>
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</table>

About the functions in the application they would like to perform to manage hypertension, tracking blood pressure, salt intake, and weight as well as checking the summary data of the measurements
were mostly favored. The results are displayed in table 7-3. Regarding the reminder for entering food journal, blood pressure check...etc., receiving it via email or short message on phone were preferred. However, 3 participants stated that they did not want the reminder.

Finally, the methods of entering the food data into the food journal, 11 participants preferred to select foods from a list while 2 participant liked to use the combination of typing data themselves and selecting from a pre-defined list.

Table 7-3. Preference of functionalities performed on mobile device

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<thead>
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<th>Functionalities</th>
<th>Number (n=16)</th>
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<td>Blood pressure</td>
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<td>Summary of data</td>
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<td>Weight</td>
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<td>Alcohol intake</td>
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<tr>
<td>Preferred way of receiving the reminder</td>
<td></td>
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<tr>
<td>email</td>
<td>6</td>
</tr>
<tr>
<td>Short message on phone</td>
<td>5</td>
</tr>
<tr>
<td>Don’t want reminders</td>
<td>3</td>
</tr>
<tr>
<td>Alarm on phone</td>
<td>1</td>
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<tr>
<td>Preferred data entry method in the food journal</td>
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</tr>
<tr>
<td>Selecting from options</td>
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</tr>
<tr>
<td>By typing</td>
<td>4</td>
</tr>
<tr>
<td>Combination of both methods</td>
<td>2</td>
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</table>
Chapter 8
Discussion and Conclusions

8.1 Discussion

In this project, we designed an application on salt intake and blood pressure management for hypertension patients with three iterations of evaluation and refinement. We carried out interviews, usability tests and surveys to explore seniors’ opinions on the app. From the results, we had the following conclusion which contains two topics: the usability design of the health self-management tool for elderly and the users’ attitude towards the app.

8.1.1 Usability and the Need of the Health Self-Management Tool

User Interface Design

About our design, we found that care should be taken when choosing pictures. Small pictures should be avoided and text should be presented along with pictures if possible. Furthermore, from the usability test, participants mentioned that they first looked at the pictures, hence the pictures should be relevant and easy to understand. The preference of graphics was also revealed in another tablet touch-screen interface design for seniors (Verdezoto & Grönvall, 2012).

Secondly, in our design, we found the design of the progress bar was critical. The ambiguity in presenting the information and the clickable button should be minimized and a clear design to catch users’ attention is needed. It might be logical to locate the progress bar in the top of the application. However, this has to take the seniors’ limited focus area into account. Normally, seniors focus on the center area more and ignore the area outside of that (Phiriyapokanon, 2011).

Thirdly, the consistency of information presentation is important otherwise it will cause confusion. This is in line to the findings from Or and Tao (2012).

Interaction Design

From the design guidelines in the previous studies, the flat-structured menu is most favorable in the design for seniors. In this project, we concluded that finding the balance between a flat-structured menu and efficiency is more important. The structure of the menu should be designed as flat as possible according to the number of functionalities and the length of each task.

With regard to the task design, doing one task at a time in order not to divide seniors’ attention is suggested in the previous design guidelines (Phiriyapokanon, 2011). However, we found that combining relevant tasks may be more intuitive to users. For instance, in our first two prototypes, selecting foods and entering the amounts were in two separate steps, while in the last prototype, these two tasks were done in one step. The number of times the participants asked “where to enter the amount” decreased remarkably.
Learnability

Regarding the learnability, most participants stated that they could get used to the app after using it a few times. However, many of them also remarked that an instruction of how to use the app would be especially helpful for seniors.

8.2.2 Attitude towards the Health Self-management Tool

Barriers and Drivers of Adopting the Self-Management Tool

The first barrier we found was that the participants were satisfied with their current condition. Self-confidence also played an important role in this. When they believed that they were already living very healthily, the measurements were stable and food intake were almost the same every day, they did not see the need for monitoring it.

The second barrier appeared to be a practical or had a technological reason. It may be because they did not have a blood pressure meter at home, the device was expensive or they did not know the app existed. Additionally, if the app or device was complicated to use or the result was not reliable, the motivation of using it would decrease.

The third barrier can be induced from the lack of further information about the salt intake result. Educational information and coaching messages could help them adjust their lifestyle according to the result. Finally, negative emotional influence from being aware of their conditions would impede their adoption of the app. Some people would rather not know their conditions, otherwise it would make them worry more.

Besides the barriers, some factors could motivate people to use this tool. Firstly, they would choose to change life style in order to lower medication. By tracking their blood pressure and salt intake, it can help them achieve this goals. Their second motivation was that it can help them control hypertension better and prevent condition from getting worse. The motivation raises especially when they can see the actual decreasing in the blood pressure. Thirdly, the ease of use was also an important role in whether to adopt the app or not. Lastly, suggestions by doctors or other professionals could be the drivers for using it.

Benefit from Using the Blood Pressure Management Tool

First benefit the participants could see was that they could be more aware of what they ate and confront their health problems. Another obvious benefit was that they could track the change of their blood pressure with the adjustment of the diet. Finally, they could obtain more knowledge about the amount of salt in foods.

On the other hand, it was also suggested that this app might benefit more people who were younger, fat or had high blood pressure more.

Expectations

With regard to the salt intake management, we discovered that the participants expected a more complete food list and an accurate result. Furthermore, the participants hoped to receive more
information on the salt intake result and coaching messages to advise them on diet change. Besides the salt intake and blood pressure management, participants also like to track other measures such as alcohol intake, exercise, heart beat rate and medication. From the view of the app, the stability of the app and the additional elements that they would find more attractive were expected by the target users.

8.2 Limitations and Future Work

Several limitations of this study should be noted. First, with regard to the content design, the list of food was recognized as being not complete or up-to-date for the participants. This could result in the hesitation of adopting the app and the distrust of the result. Second, the participants in our study had relatively high education level, had experience with computer and all lived in Amsterdam area. In addition, 69% of them were aged in the range of 65 to 69. Therefore, the results may not be representative of other seniors with different educational backgrounds and demographical characteristics. Third, we performed the interviews and usability tests in English which is not the native language of the researchers nor the participants. This might lead to some misunderstandings and limit the findings we had. Fourth, we did not evaluate an alternative application or evaluate it with a different age population. Hence, we could neither compare our app with other designs nor compare the usability between seniors and younger people. Last, we performed the studies in a lab setting environment, this may influence the results we had.

With these limitations, we suggest that a larger sample population with more diverse characteristics should be included in the future. The application should be assessed in a real-life setting and for a longer period of time in order to evaluate the acceptability of the application. Finally, with regard to the functionality, a user manual, complete food list and accurate result can improve the adoption of the app. Furthermore, to enhance the effect of health self-management app on lifestyle modifications, a personalized coaching program should be considered.

8.3 Conclusions

This study shows that a simple user interface with clear pictures, intuitive flow and flat-structure menu coupled with an instruction can improve the usability and efficiency of the hypertension self-management tool for seniors. A complete food list and an accurate result can earn seniors’ trust which encourages them to adopt a new technology. Sufficient information can increase seniors’ willingness of using such apps in the sense of helping them to interpret the results and guiding them in what actions they should apply.

The hypertension self-management app can benefit people in different ways based on their specific needs. For the people who perceive themselves as living a healthy lifestyle, the app can provide correct information about the amount of salt in different foods, thereby altering their perception of food and the actual amount of salt in it. For the people who should change their lifestyle because of an urgent condition (e.g. high blood pressure), it can support them to monitor their condition, raise the awareness of their condition and further modify their lifestyle by a coaching program. Ultimately, the hypertension self-management app can be a useful and convenient tool in personal health care and prevent severe consequence and health problems.
Bibliography


## Appendices
### Appendix A Apps on Salt Intake

<table>
<thead>
<tr>
<th>Method to estimate salt amount</th>
<th>Sodium Cravings</th>
<th>Sodium One</th>
<th>Sodium 101</th>
<th>iSodium – iNutrient</th>
<th>Sodium Tracker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Food and restaurants database</td>
<td>Food and restaurants database</td>
<td>Restaurant database, package food, cooking salt</td>
<td>Based on USDA national nutrient database</td>
<td>Self-entering the amount of salt</td>
</tr>
</tbody>
</table>

### Snapshots

- **Sodium Cravings**
  - Food and restaurants database
  - Set Daily Sodium Goal: 3500 mg
  - Create New Food
  - Track Sodium Intake
  - Set Pill Reminders

- **Sodium One**
  - Food and restaurants database
  - Search All Foods
  - Common Foods
  - Restaurant Foods
  - Supermarket Foods
  - Favorite Foods
  - Recent Foods
  - Custom Foods

- **Sodium 101**
  - Restaurant database, package food, cooking salt
  - Nutrition Facts
  - Total Fat: 9 g
  - Sodium: 530 mg
  - Calories: 200 mg

- **iSodium – iNutrient**
  - Based on USDA national nutrient database
  - 100% Natural Granola with Raisins, Low Fat
  - Calories: 195
  - Description: Cereals ready-to-eat, QUAKER, Low Fat 100% Natural Granola with Raisins

- **Sodium Tracker**
  - Self-entering the amount of salt
  - Today’s Sodium: 870 mg
  - 1,430 mg
  - Weight: 50.0 grams
  - Common Measure: 1/2 cup
  - Sodium: 117 mg
  - Calories: 195

- **Snapshots**

  - Sodium Cravings
  - Sodium One
  - Sodium 101
  - iSodium – iNutrient
  - Sodium Tracker
Appendix B Interview Questions of the First Iteration

Interview topic guideline

WARM UP AND INTRODUCTION

BACKGROUND QUESTIONS

1. Do you know what causes your condition?
2. What do you do to manage your hypertension?
   a. Do you track your blood pressure? Have you kept a food journal before?
      (on paper? use technology?)
      i. If yes, what is your experience with that?
         1. Do you find it helpful? why?
         2. Do you have difficulties? Why?
      ii. If no, why not?
3. To what extent do you think healthy lifestyle is important in managing hypertension?
4. Will you be willing to change your diet? Or the things causing your hypertension? How? Why not?
5. Regarding your hypertension, do you have the need for more information? Do you feel that you currently can control your blood pressure sufficiently?
6. Is there anything else that can help you to manage your hypertension?
   a. Is it difficult or laborious? If so, why?
   b. Do you feel the need for technology or application that can help you to manage your hypertension?

You are going to be shown an example of an application which would be available on computer or mobile devices

USER INTERFACE

1. What do you think about the interface? Why?
2. What do you like or dislike? Why?
3. Visual presentation
   a. Is the layout of texts, images and buttons on the page clear to attract attention?
   b. How easy or difficult to read the text? Is the text big enough or too small?
   c. How comfortable do you feel about colors on the page?
4. Comprehension
   a. Is there any phrase that you don’t understand its meaning?
   b. Is there any image that you don’t understand its meaning?
   c. Is there any question that is difficult for you to find a response option?

PLATFORM

1. Among these platforms, which one do you prefer to use this tool on?
2. What do you like and dislike about these platforms? why?
APPLICATION

1. What do you expect from this kind of application?
2. Would you use it? Why? Why not?
3. What is the benefit do you see by using this kind of application?

WRAP UP AND THANK PARTICIPANT
Appendix C Demographics and Technology Use Questionnaire (in Dutch and English)

Sectie 1: Demografische gegevens vragelijst

1. Leeftijd:
   - □ 65-69   □ 70-74   □ 75-79   □ 80-84
2. Geslacht:
   - □ Man   □ Vrouw
3. Opleidingsniveau
   - □ Basisschool   □ Middelbare school   □ Voortgezet onderwijs
   - □ Anders:
4. Hoe lang heeft u deze aandoening – hoge bloeddruk (jaar/maand)?
5. Hoe vaak meet u thuis uw bloeddruk?
   - □ Nooit   □ Dagelijks   □ Wekelijks   □ Maandelijks
   - □ Anders:
6. Hoe vaak gaat u uit eten?
   - □ 3-5 keer per week   □ 1-2 keer per week   □ één keer per maand of minder
   - □ Anders:
7. Wie kookt er bij u thuis?

___________________________________________________________________

Sectie 2: Gebruik van technologie

1. Internet gebruik (jaren):
2. Hoe vaak gebruikt u het internet?
   - □ vaker dan 3 keer per dag   □ iedere dag   □ 3-5 keer per week
   - □ één keer per week   □ één keer per maand of minder
3. Via welk apparaat maakt u het meest gebruik van internet
   - □ Computer/laptop   □ Tablet   □ Mobiele telefoon   □ Anders:
4. Welke van de volgende apparaten heeft u in uw bezit?
   - □ Computer/laptop   □ Tablet   □ Mobiele telefoon
5. Waar gebruikt u uw mobiele apparaat het meest voor (indien van toepassing)? U kunt hierbij meerdere opties selecteren.
   - □ Gesprekken   □ SMS   □ Alarm   □ klok   □ e-mail
   - □ Social networking (Facebook, skype..etc.)   □ nieuws lezen
   - □ foto’s maken   □ films afspelen/bekijken   □ spelletjes spelen
   - □ muziek luisteren   □ Informatie zoeken   □ Anders:
   - □ Journaal bijhouden met informatie over:

62
□ Gewicht □ Bloeddruk □ zout consumptie □ Alcohol gebruik
□ Lichamelijke activiteit
□ Samenvatting van gegevens (bijv.: bloeddruk fluctuaties)
□ Anders:

II. Herinnering om uw voedsel-journaal aan te vullen, uw medicijnen in te nemen, uw bloeddruk te meten, etc.

□ Via email □ Via alarm op uw telefoon
□ Via een kort bericht op uw telefoon □ Anders:

7. Welke manier heeft uw voorkeur om uw voedsel-journaal in te vullen?

□ Typen □ kiezen uit een lijst □ Anders :
Section 1: Demographic questionnaire

1. Age:
   - □ 65-69
   - □ 70-74
   - □ 75-79
   - □ 80-84

2. Gender
   - □ Male
   - □ Female
   - □ Others

3. Educational level
   - □ Primary
   - □ Secondary
   - □ University
   - □ Others:

4. For how long do you have this condition – hypertension (years/months):

5. How often do you measure your blood pressure at home?
   - □ Never
   - □ Daily
   - □ Weekly
   - □ Monthly
   - □ Others:

6. How often do you eat out?
   - □ 3-5 times a week
   - □ 1-2 times a week
   - □ Monthly or less
   - □ Others:

7. Who does the cooking at home?
   _____________________________________________________________________

Section 2: Technology usage

1. Internet use (years):

2. How often do you use Internet?
   - □ More than 3 times a day
   - □ Every day
   - □ 3-5 times a week
   - □ Once a week
   - □ Monthly or less

3. Common mode of Internet access
   - □ Desktop/laptop
   - □ Tablet
   - □ Mobile phone
   - □ Others:

4. Which of these devices do you have?
   - □ Desktop/laptop
   - □ Tablet
   - □ Mobile phone

5. What do you usually do with mobile device if you have?
   - □ Calls
   - □ Text messaging
   - □ Alarm
   - □ Watch time
   - □ Receive email
   - □ Social networking (Facebook, skype..etc.)
   - □ Read news
   - □ Take picture
   - □ Watch video
   - □ Play game
   - □ Listen to music
   - □ Search for information
   - □ Others:

6. Please select the functions that you would perform to manage hypertension.
   I. Self-tracking diary
      - □ Weight
      - □ Blood pressure
      - □ Salt intake
      - □ Alcohol intake
      - □ Physical activity
      - □ Summary of data (e.g. blood pressure trends)
      - □ Others:
   II. Reminder for entering food diary, medication, blood pressure check...etc.
      - □ By email
      - □ By alarm on phone
      - □ By short message on phone
      - □ Others:

7. Which way will you prefer to enter the food diary?
   - □ By typing
   - □ Select from options
   - □ Others:
Appendix D Interview Questions of the Second and Third Iteration

Interview topic guideline

BACKGROUND QUESTIONS

1. Do you know what causes your condition?
2. What do you do to manage your hypertension?
   a. Do you track your blood pressure? Have you kept a food journal before?
      (on paper? use technology?)
      i. If yes, what is your experience with that?
         1. Do you find it helpful? why?
         2. Do you have difficulties? Why?
      ii. If no, why not?
3. Will you be willing to change your diet? Or the things causing your hypertension? How? Why not?
4. Do you feel that you currently can control your blood pressure sufficiently?
   a. Regarding your hypertension, do you have the need for more information?
   b. Is there anything else that can help you to manage your hypertension?
      i. Is it difficult or laborious? If so, why?
      ii. Do you feel the need for technology or application that can help you to manage your hypertension?

APPLICATION

1. How was your experience with this application?
2. What do you like or dislike?
3. Was the application easy to use? or unnecessarily complex?
4. Did you find it was effective to use this application?
5. How confident did you feel when using this application?
6. Do you think you need help from others or need to learn how to use it?
8. What do you expect from this kind of application?
9. What is the benefit do you see by using this kind of application?

USER INTERFACE

1. What do you like or dislike? Why?
2. What do you think about the interface? Why?
3. Visual presentation
   a. Is the layout of texts, images and buttons on the page clear to attract attention?
   b. How easy or difficult to read the text? Is the text big enough or too small?
   c. How comfortable do you feel about colors on the page?
4. Comprehension
   a. Is there any phrase that you don’t understand its meaning?
   b. Is there any image that you don’t understand its meaning?
   c. Is there any question that is difficult for you to find a response option?

WRAP UP AND THANK PARTICIPANT
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