

Exploring the needs of older adults regarding eHealth services that support type 2 diabetes self-management

Elisa Naskali

School of Science

Thesis submitted for examination for the degree of Master of
Science in Technology.

Espoo 28.7.2022

Supervisor

PhD Sari Kujala

Advisor

MA Paula Valkonen

Copyright © 2022 Elisa Naskali



Author Elisa Naskali

Title Exploring the needs of older adults regarding eHealth services that support type 2 diabetes self-management

Degree programme Computer, Communication and Information Sciences

Major Human-Computer Interaction

Code of major SCI3097

Supervisor PhD Sari Kujala

Advisor MA Paula Valkonen

Date 28.7.2022

Number of pages 64

Language English

Abstract

The number of older adults with type 2 diabetes is growing, which creates challenges in finding enough resources to help everyone with their diabetes self-management. Digital health services, eHealth, has been proposed as a solution to help with the issue. However, older adults still use significantly less digital services than their younger counterparts, and the services still pose challenges for many of them.

This thesis explores the needs and wants of the older adults aged 65 years and older with type 2 diabetes regarding the eHealth services that aim to support their diabetes self-management. The research was conducted as a mixed-methods study combining an online questionnaire and semi-structured phone interviews. The aim was to, first, gain a broader understanding of the target group and the topic using the questionnaire, and second, explore the topic deeper during the interviews. The survey was shared in a curated Facebook group for type 2 diabetics and got 39 answers in three weeks, 35 of which were eligible for the study. Out of the survey participants, eight were interviewed. Finally, the thesis discusses the practical implications of the results.

The results revealed several benefits, barriers, needs and wants of the older adults regarding digital diabetes care. The participants were in general interested in using eHealth services, but were opposed to them completely replacing the traditional services. The main benefits of the eHealth services were finding information online, booking appointments online, and using Omakanta services, while the most challenging aspect was learning how to use the services. These results and their practical implications provide both insights for future research, and directions on how to develop eHealth services that benefit older adults with type 2 diabetes.

Keywords accessibility, eHealth, older adults, diabetes self-management,

Tekijä Elisa Naskali

Työn nimi Tyypin 2 diabetesta sairastavien ikäihmisten sähköisiin terveystalvveluihin liittyvien tarpeiden tunnistaminen diabeteksen omahoidon tukemiseksi

Koulutusohjelma Computer, Communication and Information Sciences

Pääaine Human-Computer Interaction

Pääaineen koodi SCI3097

Työn valvoja FT Sari Kujala

Työn ohjaaja TaM Paula Valkonen

Päivämäärä 28.7.2022

Sivumäärä 64

Kieli Englanti

Tiivistelmä

Tyypin 2 diabetesta sairastavien ikäihmisten määrä kasvaa koko ajan, mikä aiheuttaa haasteita löytää tarpeeksi resursseja tukea jokaista tämän diabeteksen omahoidossa. Sähköisiä terveystalvveluita (engl. *eHealth*) on esitetty auttamaan ongelman ratkaisussa. Ikäihmiset kuitenkin käyttävät edelleen huomattavasti nuorempiaan vähemmän sähköisiä palveluita, ja palveluiden käyttö on yhä haastavaa heistä monille.

Tämä diplomityö tutkii 65-vuotiaiden ja vanhempien 2-tyypin diabeetikoiden tarpeita ja toiveita sähköisten terveystalvveluiden suhteen. Työn tarkoitus on löytää keinoja parantaa sähköisten terveystalvveluiden mahdollisuuksia tukea ikäihmisten 2-tyypin diabeteksen omahoitoa. Työ toteutettiin sekoitettuna tutkimuksena, jossa yhdistyivät internet-kysely ja puolistrukturoidut puhelinhaastattelut. Tavoitteena oli ensin saavuttaa kyselyn avulla laajempi ymmärrys aihepiiristä ja kohderyhmästä, ja sen jälkeen syventyä aiheeseen tarkemmin haastattelujen kautta. Kysely jaettiin valvotussa Facebook-ryhmässä 2-tyypin diabeetikoille ja siihen vastasi 39 ihmistä joista 35 kuuluivat kyselyn kohderyhmään. Vastanneista kahdeksaa haastateltiin.

Tulokset paljastivat useita hyötyjä, esteitä, tarpeita ja toiveita joita ikäihmiset kokevat sähköisiin diabetespalveluihin liittyen. Osallistujat olivat enimmäkseen kiinnostuneita sähköisten palveluiden käytöstä, mutta eivät halunneet niiden syrjäyttävän perinteisiä palveluita täysin. Tärkeimmät hyödyt olivat tiedon löytäminen internetistä, sähköinen ajanvaraus ja Omakannan palvelut, kun taas suurin haaste oli palveluiden käytön oppiminen. Tutkimuksen tulokset ja niiden käytännön merkitykset näyttävät suuntaa tulevalle tutkimukselle aiheeseen liittyen. Tulokset tarjoavat myös näkemyksiä siihen, miten kehittää palveluita jotka hyödyttävät ikäihmisiä joilla on tyypin 2 diabetes.

Avainsanat saavutettavuus, eHealth, ikäihmiset, sähköiset terveystalvvelut, diabeteksen omahoito

Preface

It takes a village to raise a child and it seems to have taken quite a lot of people to write my thesis too.

First, I want to thank my amazing supervisor Sari Kujala and my incredible advisor Paula Valkonen for mentoring me and giving me guidance and support with the thesis even when I felt like it was going nowhere. Likewise, I am grateful to everyone else in the DigiIN research group for providing me with the best environment for learning throughout the whole thesis process. I also want to thank Diabetesliitto for helping me with reaching the participants. Without your help, there would be no thesis.

A special thank you goes to all my friends who supported me through the ordeal. Vilma, Suvi P., Suvi K., Essi, Anna, Inka, Petra, Mia, Laura, Kirsi and everyone else who has listened to my worries during the spring, I owe you one. And mom, thank you for everything. I obviously wouldn't be here without you.

Finally, I would like to thank the whole Aalto community, for making my student life much more than anything I could ever have imagined!

Espoo, 27.7.2022

Elisa Naskali

Contents

1	Introduction	8
1.1	Motivation	8
1.2	Research objectives	9
2	Background	10
2.1	Type 2 Diabetes	10
2.1.1	Diabetes self-management	10
2.1.2	Diabetes and eHealth	11
2.2	Older adults and eHealth	13
2.2.1	Health literacy	15
2.2.2	Digital literacy	16
3	Research methods	18
3.1	Research approach	18
3.1.1	Peak experiences	19
3.2	Research ethics	19
3.3	Survey	20
3.3.1	Pilot survey	21
3.4	Semi-structured interviews	21
3.4.1	Pilot interview	22
3.5	Data analysis	23
4	Results	25
4.1	Survey	25
4.1.1	Participants	25
4.1.2	Challenges in daily life	28
4.1.3	Benefits with the current eHealth services	30
4.1.4	Challenges with the current eHealth services	31
4.1.5	Needs and wants regarding eHealth services	32
4.1.6	Peak experiences	33
4.2	Interviews	33
4.2.1	Participants	34
4.2.2	Challenges in daily life	34
4.2.3	Benefits with the current eHealth services	38
4.2.4	Challenges with the current eHealth services	40
4.2.5	Enablers for using eHealth services	41
4.2.6	Needs and wants regarding eHealth services	42

5 Discussion	44
5.1 Answers to the research questions	44
5.2 Practical implications	47
5.3 Limitations	48
5.4 Future research	49
6 Conclusion	50
References	51
Appendix A: Survey	59
Appendix B: Interview Questions	64

1 Introduction

1.1 Motivation

Diabetes is a major health concern in modern society that affects especially the older adults. In 2021 over 463 million people have been diagnosed with some form of diabetes, and the amount is expected to rise to 700 million people by the year 2045 (International Diabetes Federation [IDF], 2021), in Finland, over 500 thousand people have been diagnosed (The Social Insurance Institution of Finland [KELA], 2020). Majority of the diagnosed cases in Finland are type 2 and, according to the record of entitlements to medicine reimbursements by The Social Insurance Institution of Finland, around 60% of them are 65 years old or older (KELA, 2020).

In the treatment of type 2 diabetes, lifestyle interventions and changes hold an important role (Nathan et al., 2009). Particularly healthy diet and weight loss have been proven key in both preventing and postponing the onset of type 2 diabetes, and improving the glycemic control of the people suffering from it (Davies et al., 2018; Kirley & Sachdev, 2018). Thus, in the treatment of type 2 diabetes, the role of self-management is crucial (Adam et al., 2018). However, for conducting the self-management plan successfully, many patients require a sufficient of support and counseling from professionals (Davies et al., 2018), and this is especially true for the older adults. Unfortunately, according to a survey conducted by Finnish Diabetes Association, both the people with type 2 diabetes and the health professionals think that the patients in Finland are not provided with enough support (Koski, 2021).

While personal counseling by a real professional is invaluable (Vermunt et al., 2012), the lack of resources, particularly in the public sector, make providing help for everyone challenging. Therefore, it is essential to create alternative ways to support the patients. Digital healthcare, or eHealth, has been rising in importance, and its significance can only be assumed to increase in the future. Digital services have been proposed to help patch the support system for people with type 2 diabetes (Kirley & Sachdev, 2018; Ramadas et al., 2011). However, older adults often have more challenges using digital services compared to their younger counterparts. According to an analysis of the Eurobarometer 87.1 survey (European Commission, 2017), only 44% of people over the age of 65 reported possessing enough digital skills to perform tasks related to daily life compared to the 95% of young people (Vasilescu et al., 2020). Accordingly, the needs of the older adults regarding the kind of support they wish for can differ from younger people (Aula, 2005), and it is vital that during the product or service development process, they are taken into consideration from the beginning. Thus, more studies are required to gain a good enough understanding of them (O'Connor et al., 2016).

This master's thesis was written as a part of the DigiIN Project. The project aims to improve the eHealth service sector to better include vulnerable groups that might be

at risk of marginalization and exclusion as the health industry continues to become more and more digitalized (DigiIN, 2021).

1.2 Research objectives

The objective of this thesis is to find out how eHealth services can be used to support the diabetes self-management of older adults with type 2 diabetes in a way that meets their needs.

Due to both eHealth and type 2 diabetes being such global issues, some previous studies on eHealth for diabetes (Arambepola et al., 2016; Ramadas et al., 2011; Ronda et al., 2014), and on eHealth for older adults (Eriksson-Backa et al., 2021; Siren & Knudsen, 2017; Wildenbos et al., 2019) exist. However, despite of the majority of type 2 diabetics being over 65 years old, the needs specific to the older adults with type 2 diabetes have not been that widely studied in this regards.

The research focuses on both evaluating the strengths and shortcomings of the currently available eHealth services, and on exploring and identifying potential new areas for them. The research questions are as follows:

RQ 1: “How does diabetes affect the lives of the older adults with type 2 diabetes?”

RQ 2: “What benefits and challenges do the older adults with type 2 diabetes experience using the currently available eHealth services?”

RQ 3: “What needs and wants do the older adults with type 2 diabetes have regarding eHealth services?”

The aim of the first question is identifying potential needs that might not be immediately obvious. In the second question, the benefits might be not only perceived usefulness, but also elements, such as, satisfied curiosity or enjoyability. The third question is partly answered by first exploring the questions two and three.

In addition, this thesis will address the health- and digital literacy of the participants as both of the skills have been found to correlate with successful diabetes self-management (Juul et al., 2018; Karnoe et al., 2018).

2 Background

2.1 Type 2 Diabetes

Diabetes mellitus is an autoimmune disease that targets the insulin metabolism (Roglic, 2016). Type 2 diabetes is typically defined by the cells having an increased resistance to insulin, resulting in it not being absorbed properly and thus having increased amount of glucose in the blood. It is most common with older adults, other factors that increase the chance of developing it including metabolic syndrome and genetic predisposition (Roglic, 2016).

This section will first discuss the general diabetes self-management practices. After that, it will proceed to review the eHealth solutions that have been developed to help in the self-management of the disease, and how they have been previously studied.

2.1.1 Diabetes self-management

Self-management, referring to healthy eating, sufficient exercise, healthy coping, medication, monitoring and reducing risks, (Adam et al., 2018; Adu et al., 2019) is an essential part of diabetes care. Sufficient self-management skills and confidence in them are important enabling factors in successful diabetes self-management, as in order to gain motivation, it is vital to believe you can affect the situation (Adu et al., 2019).

One of the most crucial parts of diabetes care is diabetes self-management education, since without it the patients cannot make informed decisions in their daily life with diabetes (Adam et al., 2018; Davies et al., 2018). In addition, continuous self-management education and reinforcement has been shown to be particularly helpful for the patients (Adu et al., 2019). Other enablers for successful diabetes self-management include support from family members and other people with diabetes, motivation, good communication with and trust in healthcare professionals, and assistive technology (Adu et al., 2019). In particular, healthcare professionals should support the autonomous motivation for physical activities, as physical activity is an important part of successful diabetes self-management (Koponen et al., 2016).

In their article “*Enablers and barriers to effective diabetes self-management: A multinational investigation*”, Adu et al. (2019) identify that major barriers for successful diabetes self-management include difficulties changing lifestyle, financial constraints, diabetes-related stress and insufficient communication with healthcare. In addition, they state that lack of knowledge about proper diet plans or personal beliefs about the medication can hinder how well a person complies with the treatment plan. They also state that as diabetes, especially type 2, is progressive and the symptoms might differ from time to time, managing it can be even more challenging. This

can make the treatment fatigue worse. What is more, they mention that diabetes can cause side-effects, such as physical pain or mental fatigue, that make engaging in self-management activities more difficult. Lastly, they mention that unrealistic expectations for the treatment from either the patients or the people close to them can lead to disappointments. The study also showed, that in fear of hypoglycemia, the patients would sometimes engage in unhealthy behavior, such as unhealthy eating or lowering their medication (Adu et al., 2019).

2.1.2 Diabetes and eHealth

Digital services that focus on general health care, such as online booking of appointments, can help with diabetes self-management. In addition, some digital services, both web-based and mobile applications, have been developed for managing diabetes specifically. These services can, for example, help with calculating insulin doses, assist with monitoring blood glucose, provide diabetes education, or offer better access to healthcare professionals (Shan et al., 2019).

There have been some previous studies examining the specifically diabetes-related needs for digital health services. For example, Pal et al. (2018) conducted a study on adult diabetics focusing on their perspectives on diabetes self-management support and education. They identified several needs for patients for digital diabetes services, including requiring specific instructions on different aspects of diabetes, such as weight management and medication side-effects. In particular the participants hoped for advice on the diabetes diet.

The selection of digital health services vary depending on the country. In Finland, online booking is offered by 59% of the health centers, and anonymous question/answer services by 16% of them (Vehko et al., 2019). In addition, the Finnish online medical record service Omakanta (Kanta Services, 2022) that offers services, such as, checking the records of healthcare visits and renewing prescriptions, is visited by almost 20% of the population of Finland monthly (Kanta Services, 2022).

In Finland, patients can use Sensotrend (Sensotrend Oy, 2020) to sync their blood glucose measurement results automatically to Omakanta where healthcare professionals can access it. It is, however, unclear how widely it is used. Besides that, there are not very many eHealth services targeted specifically towards diabetics. In addition, many of the existing services offer little interactivity and focus on providing information in a more traditional format.

When they are available, digital services have potential to be effective in aiding in diabetes self-management (Kirley & Sachdev, 2018; Pacaud et al., 2012; Ramadas et al., 2011). A literature review conducted by Ramadas et al. (2011) discusses different web-based interventions for type 2 diabetes. In the study, they concluded that web-based interventions, especially online peer-support groups, setting goals,

and services providing interactive feedback are usually effective. They continued however, that the effects tend to decrease within time due to the participants losing interest. They concluded that reminders via, for example, e-mail or SMS can help with delaying the effect. In addition, having a medical professional involved in the process also increased the effects.

A systematic literary review conducted by Arambepola et al. (2016) also suggests that interventions using automated messaging via SMS are able to affect the blood glucose levels of the participants positively, but might not have a significant effect on their body mass index. Automated two-way text messaging where participants received messages and reminders for checking their blood glucose, and had to respond back after doing so, and email messaging have also been tried with similar results (Hunt, 2015).

An encouraging finding regarding digital diabetes education, is that digitally presented education about type 2 diabetes can be as effective as in-person education (Pacaud et al., 2012). While some participants might not be as satisfied with it as with in-person care, it does not seem to affect the results. However, the patients still report a need for traditional in-person contact with the healthcare professionals (Hunt, 2015). Additionally, services that are accessible via mobile are often used more than the services that can only be accessed via desktop computer (Hunt, 2015).

As it is, use of apps to help with diabetes self-management has also been shown to correlate with better glycemic control (Debong et al., 2019), although results obtained from clinical studies indicate that the effects can be limited (Shan et al., 2019). Nevertheless, apps that help monitoring blood glucose can be useful for many diabetics, especially those with poor glycemic control, as seeing previous entries makes it easier to understand the effects of actions and adjust them accordingly (Adu et al., 2019). Particularly apps that show graphs for blood glucose levels have been reported useful in both managing diabetes and increasing health knowledge, although technical difficulties can have a negative impact on that (Hunt, 2015). Still, the patients wish for easy contact with health personnel, and want to participate in choosing the technology (Hunt, 2015).

Some of the mobile applications available for general use worldwide include mylife (Ypsomed AG, 2022) that offers its users blood glucose information and remote control of their insulin pump, FreeStyle LibreLink (Abbott, 2021) that can be used to scan blood glucose sensor directly and provides easy interface for reading blood glucose levels including trend arrows, and mySugr (Roche Diagnostics, 2022) that synchronizes with the user's blood glucose meter and provides easy monitoring of blood glucose and insulin levels. Out of them, at least mySugr has been studied and shown to have positive impact on the blood glucose levels of its users (Debong et al., 2019).

In their article *Big Data and diabetes: the applications of Big Data for diabetes care now and in the future* Rumbold et al. (2020) also suggest utilizing big data to aid

in diabetes self-management. They see potential in utilizing it in both diagnosing diabetes, and finding better treatment methods. While they acknowledge that as health related data is very sensitive, access to it is and should be restricted legally, they think that in the future diabetes-related data will be used to power AI and machine learning based treatments for those affected. Similarly, Ellahham (2020) also lists multiple avenues where AI can and has been used to aid in diabetes treatment including support for self-management and self-treatment for those with diabetes, and clinical decision-making for doctors.

2.2 Older adults and eHealth

Digital health services have been shown to be useful in health management. They hold potential for especially the people who have more health issues, such as older adults (Eriksson-Backa et al., 2021). Unfortunately, the use of internet and online health services has been shown to be significantly lower among people over the age of 60 than in the younger age groups (Heponiemi et al., 2022; Siren & Knudsen, 2017). However, rather than stemming from biological aging-related factors, the differences are more likely to result from lack of exposure and experience, as well as unwillingness to use the services (Siren & Knudsen, 2017), although biological aging-related factors can affect the needs of the older adults regarding the usability of the services as well (Aula, 2005). That being said, many older adults are interested in using digital health services (Eriksson-Backa et al., 2021; Ranieri et al., 2021).

Comincioli et al. (2021) argue that studying older adults as users of digital services can easily fall victim to implicit ageism. The focus is put on addressing their needs and age-related issues without paying much attention to their intrinsic capabilities. Additionally, older adults are often treated as a homogeneous mass with identical needs. In actuality, while researching the needs of older adults regarding digital solutions is important, it is also important to explore the wants they have for the services (Mannheim et al., 2019; Newell, 2011).

Internet use varies between older adults. A study conducted in South Korea (Park & Kim, 2020) researched the readiness of older adults with diabetes to use digital interventions and identified three sub groups of older adults. The first group was *smart users*, who were confident in their internet skills and used it for various purposes. Compared to other groups, they were generally younger, active and were in a higher socioeconomic position. They also rated their overall health-score higher. The second were so-called *communicating users*, who mainly used the internet for communicating via, for example, e-mail, text-messaging and social media. They had generally higher socioeconomic standing than the third group and exhibited the least amount of depressive symptoms. The third and largest group were the *non-users*, who also reported the weakest self-rated health-scores and generally belonged to a significantly lower socioeconomic group compared to the other two groups.

A Danish study conducted via phone surveys by Siren and Knudsen (2017) in turn identified three groups of older adults as users of information and communications technologies (ICT). They called these *ICT confident*s, *reluctant users*, and *ICT challenged*. *ICT confident*s found digital services useful, did not have major challenges with them, used internet regularly, and were not very worried about losing personal contact. *Reluctant users* on the other hand recognized the benefits of digital services. However, they had less confidence in using them, though they were willing to learn. They were also more worried of losing personal contact. The last group, *ICT challenged*, generally had little experience and skills in using digital services, combined with disinterest in learning them.

The use of online health services has been shown to benefit older adults for example by helping them manage and improve their health habits, alleviating loneliness, and supporting independence (Ranieri et al., 2021). Social media, for example, can serve as a platform for older adults to share information with each other (Cotten, 2017). In general, the use of technology can also help protect older adults against cognitive decline (Ranieri et al., 2021). In addition, using eHealth interventions can boost the older adults' levels of physical activity at least in the short term (Muellmann et al., 2018).

Being taught how to use the services at their own pace can help older adults use digital services (Aula, 2005). Other identified enablers include having information in the same place, reducing the amount of phone calls, and being easy to use (Eriksson-Backa et al., 2021). Keeping functionality to the minimum can bring clarity to the service and reduce confusion (Newell, 2011).

Besides lack of exposure, identified barriers for older people with using online services include cognitive decline, physical ability, and challenges with visual perception (Wildenbos et al., 2018), as well as computer anxiety (Ware et al., 2017). Examples of lesser physical ability can include the lack of manual dexterity, for example challenges with double-clicking objects, while challenges with perception can be, for example, challenges identifying relevant information within a display, or lessened peripheral vision (Newell, 2011). In addition, usability issues can act as a barrier for older people to use digital services (Andrews et al., 2019; Ware et al., 2017). Their effect can be significant, because for example, even things such as the appearance of a service suddenly changing, due to, for example a brand renewal, can be upsetting and cause confusion for older adults (Aula, 2005; Eriksson-Backa et al., 2021). However, positive experiences with digital services in turn, lead to the user being more likely to use the service again (Karisalmi et al., 2019).

When using online health services, older adults are also often concerned about the privacy of the information (Eriksson-Backa et al., 2021; Heponiemi et al., 2022; Ronda et al., 2014; Ware et al., 2017), but the worries can be mitigated by communicating the message correctly (Ware et al., 2017).

A typical eHealth service older adults use are electronic patient accessible electronic

health records (PAEHR), such as the Finnish Omakanta, though older adults generally use them less than younger ones (Heponiemi et al., 2022). However, those who utilize PAEHR:s, typically use them often and in diverse ways (Arcury et al., 2017). Frequent PAEHR:s users often have chronic illnesses (Hoogenbosch et al., 2018) and they often find the different features that help them with managing their illness very valuable (Ronda et al., 2014). Use of the records can help older adults learn more about their health and take more responsibility in caring for it (Eriksson-Backa et al., 2021; Ware et al., 2017). In addition, it can lead to improved diabetes control (Osborn et al., 2010).

A common reason people do not use PAEHR:s is that they are not aware of them (Ronda et al., 2014). Encouragement from healthcare personnel is a major factor in PAEHR use (Hoogenbosch et al., 2018) and can lead to more people finding them.

2.2.1 Health literacy

Health literacy refers to being able to understand and evaluate health information, and to apply said information in one's life to help manage health and prevent diseases (Sorensen et al., 2012). Health literacy can be further divided into three principal components: First, *functional* health literacy meaning the general writing and reading ability related to health. Second, *interactive/communicative* health literacy which refers to being able to gather health information from communication. Finally third, *critical* health literacy meaning the ability to analyze and evaluate the information to achieve better control (Juul et al., 2018).

A high enough level of health literacy enforces autonomy (Eronen et al., 2019) and is a requirement for successful health self-management, especially with diabetes (Shan et al., 2019). Utilizing any health services independently, digital or not, can become too challenging if the user has difficulties understanding the information. High level of health literacy has also been shown to support active aging, even with multiple chronic conditions (Eronen et al., 2021). Particularly for people with type 2 diabetes, a higher level of functional health literacy has been shown to correlate with higher levels of physical activity, which in turn leads to better diabetes care outcomes (Juul et al., 2018). Higher health literacy also correlates with more active PAEHR use, which can lead to better diabetes care (Arcury et al., 2017).

Sufficient levels of diabetes health-literacy are needed for patients to be able to understand the instructions. This is especially important, as patients with lower levels of health literacy have a smaller probability of communicating their issues to a healthcare professional, leading to worse outcomes (Lee et al., 2018). Lower levels of health literacy also correlate with lesser use of electronic patient portals (Arcury et al., 2017). While fear of loss of contact with health personnel might act as a barrier in portal use, bad quality communication with the personnel can also encourage the use of portals (Arcury et al., 2017).

Several evaluated questionnaires exist for assessing health literacy. These include TOFHLA (Al Sayah et al., 2012), eHLA (Furstrand & Kayser, 2015), eHealth literacy assessment kit (Karnoe et al., 2018), SILS (Morris et al., 2006), and HLS, of which there are several versions with different number of questions (Finbråten et al., 2018; Niedorys-Karczmarczyk et al., 2020; Sørensen et al., 2013). TOFHLA, SILS and HLS focus on health literacy in general, while eHLA and the eHealth literacy assessment kit specialize in health literacy in the context of eHealth. These tools can be used to help with both research and caring for patients, as healthcare workers must be able to identify patients with lower levels of health literacy to communicate effectively (Jeppesen et al., 2009).

However, health literacy needs can also vary between different ailments. For instance, successful diabetes care requires relatively high skills in numeracy as well as literacy (Lee et al., 2018). Therefore, Lee et al. (2018) developed a health literacy assessment scale that focuses specifically on diabetes-related health literacy which they recommend for use in both research and practice.

2.2.2 Digital literacy

Digital literacy has many definitions, but most commonly it means the skills and the competence to act in digital environments and the capabilities to reflect on the material critically (Pangrazio et al., 2020). A sufficient level of digital literacy is vital for using digital services (Bhattacharjee et al., 2020) as the level of digital skills and confidence affect how easy adopting new technologies and digital services is.

A related concept is computer self-efficacy, meaning the individual's confidence in executing different computer tasks. Along with high digital literacy, higher computer self-efficacy predicts the use of online health services (Hall et al., 2015). Being familiar with technology and using digital devices regularly in addition often correlates positively with PAEHR use (Arcury et al., 2017). Both of these help support active aging and independence in older adults (Tirado-Morueta et al., 2018).

Older adults generally have lower levels of digital literacy than the younger population (Broekhuis et al., 2019; Vasilescu et al., 2020). This affects their use of digital services negatively, which can lead to digital exclusion (Oh et al., 2021). Adults over 65 in general use digital services less, which is even more true to those over the age of 80 (Heponiemi et al., 2022). Good digital literacy can decrease the negative effect of age in the usage of digital services up to a point, but it does not have as big of an effect among the oldest, for whom the reasons might be more tied to personal preferences (Heponiemi et al., 2022).

Modest digital skills, or trust in them are some of the typical motivational barriers older adults might experience when attempting to use new digital services (Wildenbos et al., 2019). To adopt new digital devices and services, many older adults have to

learn a completely new set of skills, beginning with using touch screens (Heponiemi et al., 2022). Therefore, it is not surprising that the perceived ease of use is important for the older adults who have less digital skills (Biduski et al., 2020). For example, with limited self confidence in digital skills, usability issues, such as problems logging in, or technical problems, can be very confusing (Eriksson-Backa et al., 2021), and thus pose a more significant issue. Especially when the topic is as sensitive as health, usability issues can lead to anxiety and diminishing trust in the service. Therefore, investing in usability and accessibility is extremely important when designing digital health systems for older adults. In addition, particularly within eHealth, the information should be adjusted to fit the user's level of digital literacy (Broekhuis et al., 2019).

In their paper *Older adults and their acquisition of digital skills: A review of current research evidence* Bhattacharjee et al. (2020) identify five main categories of challenges the older adults experience while learning new digital skills: challenges related to age, low perception of self-efficacy, negative attitudes from others, challenges with technology features or design, and finally complex training materials. Based on the categories, they recommend that society and the close ones of the older adults should strive to encourage the older adults more in using the services. In addition, they recommend that the training programs should be improved to cater better to the learning style of the older adults, a recommendation that is supported also by other research (Aula, 2005; Broekhuis et al., 2019).

Hall et al. (2015) too suggests that to combat the negative effects of low digital literacy, effort should be put into educating older adults with computer usage. Similarly, Tirado-Morueta et al. (2018) studied the effect of digital literacy support programs on the internet usage of the older adults, and found that the effects of older age could be decreased through the programs.

3 Research methods

This chapter has five subchapters: The first one discusses the research approach used in this study. Then, the second one will move on to presenting the ethical concerns that were taken into account while planning and conducting the study. The third and fourth subchapters proceed to introduce the actual research methods used in the study, and finally the fifth subchapter explains and justifies the data analysis methods used in the study.

3.1 Research approach

This research was a mixed-methods study utilizing both a survey and semi-structured interviews to gather both quantitative and qualitative data. The study targeted people that are 65 years old or older and suffer from type 2 diabetes.

Mixed-methods approach has been used before in researching diabetes and mobile health applications and has been deemed viable (Sahin & Naylor, 2017). An age-limit of 65 was chosen for older adults, as in previous studies it has been shown that adults older than 65 experience more usability issues (Broekhuis et al., 2019) and have less digital skills (Vasilescu et al., 2020) than younger age groups. In addition, it is close to the Finnish retirement age meaning that the participants were roughly in the same stage of life.

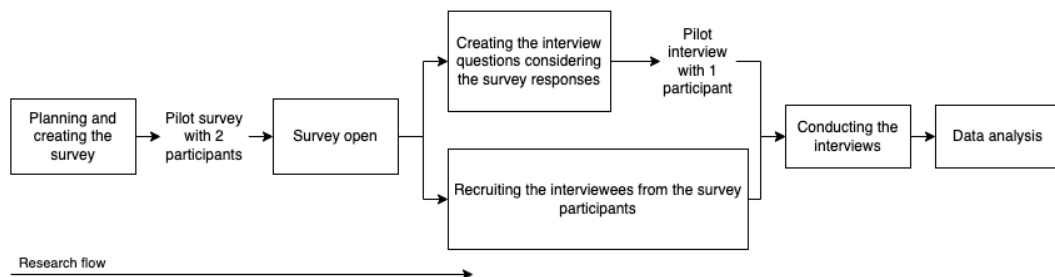


Figure 1: The research process, box sizes are insignificant

The flow of the study is depicted in figure 1. First, an online survey was conducted to provide both background information on the participants, and a broader perspective to the subject matter. Then, the interview questions were created based onto previous research and the answers to the survey. Finally, the participants were interviewed to provide a deeper view into some of the themes.

3.1.1 Peak experiences

One of the objectives of this thesis was to find out how currently available eHealth services support the self-management of type 2 diabetes. In essence, interesting for the purposes of this thesis was the long-term usability and user experience of the services, rather than the short-term experience. Measuring long-term user experience can be very time-consuming (Karapanos et al., 2009), which was out of scope for this thesis. However, a reasonably accurate way of measuring user experiences spanning a longer time frame in a shorter time frame is to utilize peak experiences (Kujala & Miron-Shatz, 2013).

The user's memories of the emotions they had while using a product or a service affect how they rate the usability of such product, positive memories leading to positively rated user experience and negative emotions resulting in lower rated usability (Kujala & Miron-Shatz, 2013). These strong memories are called peak experiences. It has been shown that positive experiences lead to the older adult users being more likely to return to the service (Karisalmi et al., 2019), while negative experiences lessen their interest in using them (Bhattacharjee et al., 2020). However, Karapanos et al. (2010) argue that these memories of the experiences can actually affect the success and user-retention of the services more than the actual experiences themselves, measures which are highly relevant for the success of eHealth services.

In the survey, two of the questions aimed to utilize the concept of peak memories to gain understanding of the usability of the eHealth services. Translated from Finnish to English, these questions were: *“Have you had a positive, pleasant experience regarding digital diabetes services?”* to gauge the positive memories, and *“Have you had a negative, bad experience regarding digital diabetes services?”* for the negative memories respectively.

3.2 Research ethics

As the subject concerned health and was considered sensitive, special care was taken to ensure participants felt safe and respected and that they could trust the interviewer. Thus, the participants were contacted several times via email before the interview, as that can help with building a relationship (Valkonen et al., 2021). Extra attention was paid to making sure the interview process did not cause unnecessary stress to the interviewees.

As the data produced in the study included health information, it was especially important to take information security into account. Any identification information was omitted from the transliterations, as well as the survey results. Any identifiable or raw data was not disclosed with any third parties. The consent form and privacy statement were modified as little as possible from existing versions approved by the Ethical Review Board of the Aalto University to suit the purposes of this research.

3.3 Survey

The first part of the study consisted of a survey aiming to gain a broader understanding of the needs and overall situation of the target group. The questions (Appendix A) focused mostly on finding out how and in what ways older adults use the eHealth services that are currently available, what benefits or challenges they experience using them, and what kind of digital services they currently enjoy using or find challenging to use and why. The questionnaire also investigated what kind of diabetes-related challenges the participants face in their everyday life.

The answers were then compared to the given background information, such as gender, how long the participants had their diagnosis, their level of comfort with digital services in general, and so on.

The survey included a screening question to find out if the participants used digital services at all. The further questions about digital service use were asked only to those who claimed using digital services, while the rest were asked for reasons for their non-use. The options for reasons to not use digital services were inspired by the study conducted by Olphert et al. (2005) as well as the consultation with other members of the research group.

For inquiring about the level of confidence of the participants in their ability to conduct digital abilities, a translated and slightly modified version of tool 6 from the Literacy Assessment Toolkit by Karnoe et al. (2018) was used. Out of the tools for measuring digital literacy in the toolkit, the tool 6 was chosen because it measured the *confidence* of the participants instead of actual skills. In previous studies (O'Connor et al., 2016; Ranieri et al., 2021), digital self-confidence has been associated with easier adoption of new digital services.

As for the health literacy, a translated version of the Single Item Literacy Screener (SILS) (Morris et al., 2006) was used. Other screening tools exist (Finbråten et al., 2018; Karnoe et al., 2018; Sørensen et al., 2013), but SILS was chosen due to its short length suiting a screening question. In addition, it has been recommended to use as a screening question with patients suffering from diabetes (Jeppesen et al., 2009). In the translation “from your doctor or pharmacy” was changed to “about health topics” as applied fits better to the Finnish’ healthcare. In addition, after the pilot test, a clarification was added to the question that the material could be in digital or physical form.

The survey was created using Webropol (Webropol.fi, 2022). Webropol provides a good and relatively secure platform for making surveys and has been widely utilized in previous studies in Aalto. The survey was open for two weeks, and the participants were able to fill it independently in their own time. To motivate people to answer the survey, gift vouchers for an ebook license were drawn between the participants who wished to participate in the raffle. To ensure anonymity, contact information for

the raffle was asked in a separate form that opened automatically after completing the actual survey.

3.3.1 Pilot survey

Before publishing the survey, a smaller pilot test of the survey was conducted to ascertain the questions were understandable, relevant, and inoffensive to the participants. In addition, before showing the survey even to the test participants, the questions were meticulously peer-reviewed with by other researchers as well as a representative of the Finnish Diabetes Association.

The pilot included two female volunteers. To protect the volunteers' privacy, their exact ages are redacted, but one of them was 76 – 80 years old with type 2 diabetes, and the other 65 – 70 years old with type 1 diabetes. The exact type of diabetes was deemed irrelevant for the purposes of testing the survey, as it was unlikely to affect the understandability of the questions.

The test itself was a basic usability test. During it a researcher filled the survey with the test participant. The researcher either sat next to the participant while the participant answered the questions, or filled the survey questions for the participant according to their instructions. The participants were also asked questions regarding the clarity of the questions.

A few changes resulted from the pilots. The main changes were:

- The link to the survey from its starting page was made clearer, as it proved difficult to find for both of the participants.
- Few of the questions were clarified as per the participants' requests.
- Originally, after submitting the results, the participant was then redirected to a new survey where they could leave their contact information for the eBook raffle and interviews. This, however, was confusing for the participants even when they were informed of it before submitting. Thus, the redirection was made more subtle.

3.4 Semi-structured interviews

The second part of the research consisted of eight 30 minutes to 1 hour long semi-structured one-on-one interviews with participants who were recruited via the survey.

Semi-structured interviews are a versatile data-collection method that is able to adapt to the interviewee's answers and allow for their experiences to be heard

without limiting them as much to the interviewer's existing conceptions (Kallio et al., 2016). The interviews in this study were likewise semi-structured to ensure enough structure, as well as to not limit the insights too much. The interview questions (Appendix B) focused on how diabetes affects the lives of the interviewees and what kind of experiences they had with digital health services, both diabetes-related and other. The aim was to find out what challenges diabetes might have caused in their everyday lives, how the possible problem situations were handled, and what aspects of their diabetes self-management the participants felt worked and what required more support. The interviewees were also asked to share their overall feelings on digital services.

Before the interviews the participants were asked to sign a consent form and send it back digitally. They were also provided with an option to send it via post if they so preferred, but none of the participants took it. Along with the consent form, the participants were provided with the privacy policy and a document with the relevant information about the study, as well as given a chance to ask any questions before the interview.

The interviews were conducted remotely due to the COVID-19 pandemic and the target group being at higher risk of a severe infection, as both old age and type 2 diabetes are risk factors for a serious infection. The participants were instructed before the interview to find a quiet environment with not too many distractions. Phone calls were utilized for the interviews to both ensure that all interviewees regardless of level of comfort with or experience with video conferencing services were able to participate, and to ensure a high level of information security. In addition, telephone interviews have previously been deemed an effective method for data collection in health research as they are cost-effective, are able to reach people regardless of the location they live in, and can reach the people who might not be in good enough condition or else willing to travel to on-site interviews (Musselwhite et al., 2007). The calls were recorded in a private setting via having the phone on speaker mode and recording the voice on a laptop with Audacity (Audacity Team, 2022).

To motivate participation, all interview participants were given a gift voucher to an ebook license after their interview was done.

3.4.1 Pilot interview

Before conducting the interviews, one pilot interview was conducted to ensure the questions were understandable and produced the intended kinds of answers, as well as to measure the required time to conduct them. In addition, before conducting the pilot, the questions were peer-reviewed by other members of the research team.

The pilot participant was 65 – 70 years old (exact age redacted for privacy) and

had type 1 diabetes, which likewise to the survey pilot was deemed irrelevant as the questions made sense regardless of the type of diabetes. The participant had participated in the survey pilot before, which made the circumstances similar to the actual participants, as they were also recruited after participating in the survey. The pilot interview proved successful and did not yield many changes outside of clarifying some questions.

3.5 Data analysis

The study produced three kinds of data; quantitative data from the survey, qualitative data from the open survey questions, and qualitative data in the form of the interviews.

The interviews were first recorded using Audacity (Audacity Team, 2022) and then fully transcribed. Transcription can be done *verbatim*, where every speech element is written exactly as the transcriber hears them including coughs and pauses and so on. The other option is to do it *selectively* where only the essential parts are transcribed while excluding the nonverbal speech elements (Azevedo et al., 2017). As verbatim transcription is more thorough, it can offer more information for the data analysis phase of the study. Selective transcription on the other hand produces more concentrated and readable transcription of the interviews, while potentially missing some of the information (Azevedo et al., 2017).

The transcription was done almost verbatim; elements such as stuttering and coughing, were excluded unless they affected the meaning of the sentence. In addition, the parts that were clearly irrelevant for the study were excluded. This was done both to conserve the limited resources and to improve the readability of the transcripts. However, emotional expressions, such as hesitating or laughing, were included, as the attitudes and feelings conveyed via those were relevant for the study.

The quantitative data produced by the survey was analyzed descriptively utilizing SPSS (Corp, 2020) and Microsoft Excel (Microsoft Corporation, 2022). Descriptive analysis is a method for statistical analysis that aims to describe the relationships between different variables inside a data sample (Kaur et al., 2018). The goal of this analysis was to determine the participants' general background information, as well as health - and digital literacy, and satisfaction with diabetes self-management control. This was done by calculating distributions, mean, median, variance and standard deviation for each of the variables.

The qualitative data produced by both the survey and the interviews was analyzed with Atlas.ti (ATLAS.ti, 2022). The survey and interview data were first analyzed separately, and then compared to each other. Thematic content analysis was used to find common themes and needs within the data. Thematic analysis is a systematic method for interpreting and analyzing emerging meaning from patterns in data (Clarke & Braun, 2017). It is applied by creating codes to represent small excerpts of

the data that are then used to interpret the larger themes in the material (Williams & Moser, 2019). The codes can be created either deductively before reading the materials, or inductively from the data (Williams & Moser, 2019).

In this study, each data set was coded inductively while reading it. Afterwards, the codes were grouped into different categories which were then reviewed again. Finally, all occurrences of challenges related to diabetes, challenges, benefits and enablers related to eHealth services, and needs and wishes for eHealth services were counted to see their prevalence within the data set.

4 Results

This chapter will first introduce the participants of the survey, and then go over the results obtained from it. It will then move on to the subset of the participants that participated in the semi-structured interviews, as well as the more in-depth results obtained from them.

4.1 Survey

This section introduces the survey participants as well as the results obtained from the survey.

In general, it was clear that the care and services available to the participants differed greatly. Some were able to use a sensor to automatically sync their blood glucose to healthcare professionals, while some could not even meet with them regularly. In addition, the participants themselves differed clearly in the amount of care they required. Therefore, the answers were really varied, and the overall results are not true for everyone but instead represent the many potential wishes, benefits, and challenges older adults can have in regards to digital diabetes services.

4.1.1 Participants

In total, 39 people answered the survey. Out of them, one reported age of under 65, one did not report their age at all, one reported type 1 diabetes, and one did not tell their status with diabetes. They were excluded from the analysis, leaving a total of 35 replies.

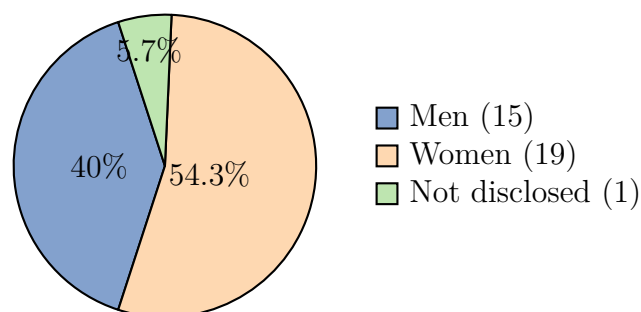


Table 1: The gender distribution of the survey participants

Out of the participants 54.3% were women, and 40% men, with one participant not disclosing their gender (Table 1). Most of them were 65 to 75 years old with 45.7% reporting age of 65 – 70 and 40% 71 – 75. As for the rest, two of the participants were aged 76 – 80 and three were between ages 81 – 85 (Table 2). The participants were

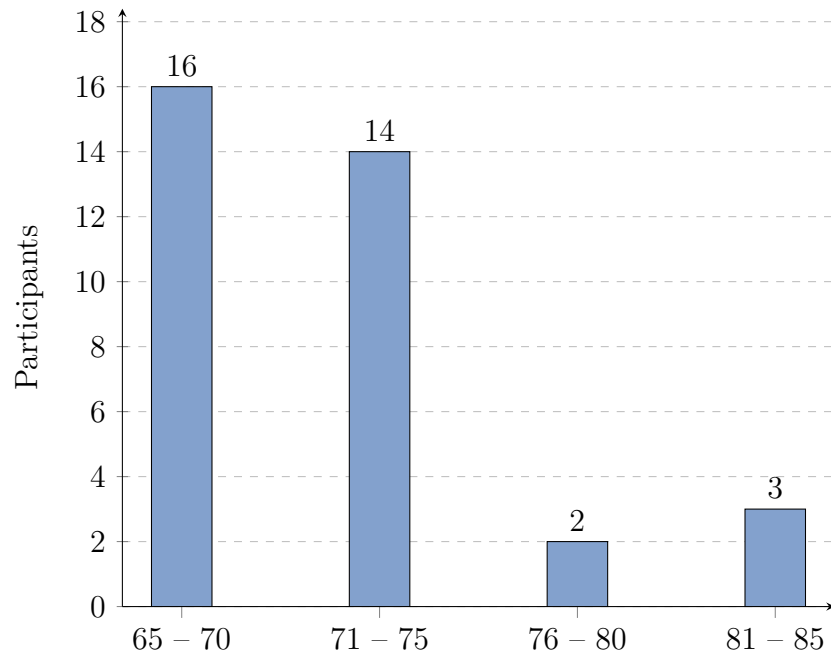


Table 2: The age distribution of the survey participants

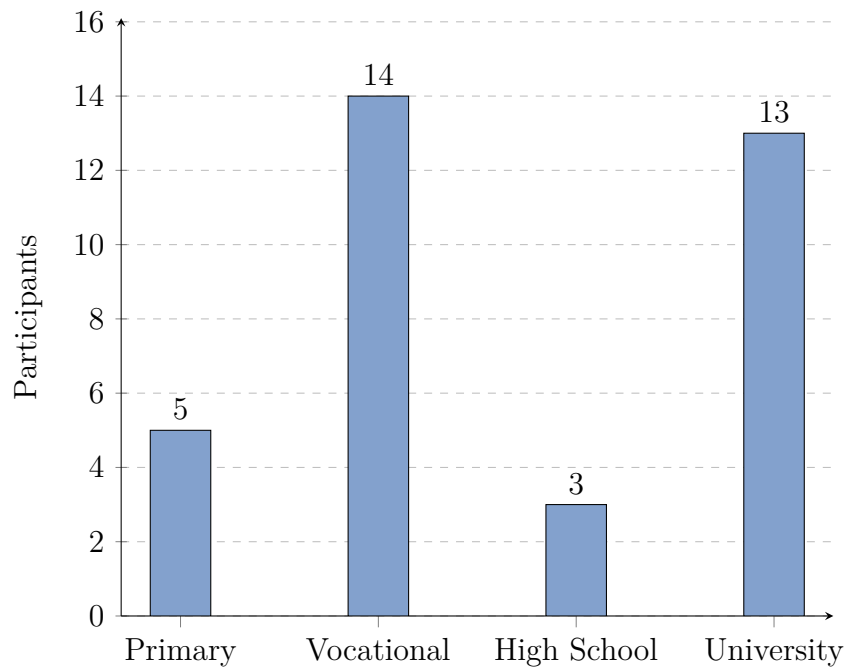


Table 3: Education levels of the survey participants

relatively highly educated with 85.7% of them having at least secondary education (Table 3). The time since their diagnosis ranged from under a year to over twenty years with 74.3% of them having been diagnosed over ten years ago (Table 4).

Based on their replies, the participants were mostly satisfied with their diabetes self-

management control, 53.8% of them reporting they were either “somewhat satisfied” or “extremely satisfied” with it. 28.3% reported neutral satisfaction, and 11.4% were somewhat dissatisfied. Nobody reported extreme dissatisfaction, and one participant did not respond to the question. On average they scored 3.74 out of 5 on their diabetes self-management control satisfaction scale with a median answer of 4. Out of them, 48.7% reported diabetes causing some challenges in their daily lives and 88.6% had used some digital service in their diabetes self-care.

Overall, the participants had a high level of health literacy (Table 5). Only 14.3% had a SILS score of 3 or higher, which would indicate some amount of challenges reading written health material. The remaining 85.7% reported either never requiring help reading health material (57.1%) or rarely requiring help reading health material (28.6%). The participants also scored an average of 9.76 out of a maximum of 12 points with a median of 10 points suggesting that their overall level of digital skills was relatively high.

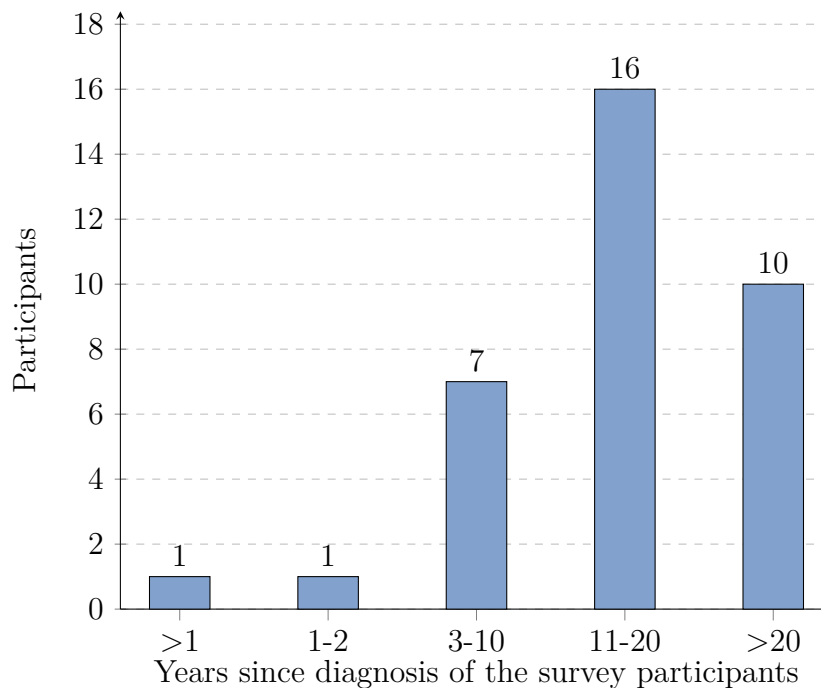


Table 4: Years since diagnosis

In general the participants were interested and willing to use digital services and most of them had already used at least some to support their diabetes self-management. Out of those who had not used a digital service, only one reported not finding them useful while the rest reported the main reason to not using them being not knowing what services they could use.

	Mean	Median	Mode	SD	Variance
Health literacy*	1.57	1	1	0.74	0.55
Confidence in digital skills**	9.76	10	12	2.35	5.52
Satisfaction with diabetes self-management control ***	3.74	4	4	0.99	0.99

Table 5: The health literacy, confidence in digital skills and satisfaction with diabetes self-management control reported by the survey participants

* 1 = High literacy, 5 = low literacy

**Maximum 12

***Maximum 5

4.1.2 Challenges in daily life

Roughly half, 48.6% of the participants reported diabetes causing them some challenges in their daily lives. However, the particular challenges varied from participant to participant resulting in a wide but shallow array of challenges (Table 6).

The challenges could be roughly divided into *challenges caused directly by diabetes* and *challenges caused by matters other than diabetes*. The challenges caused by diabetes could then be further divided into three categories: *symptoms directly caused by diabetes*, *challenges in treatment of diabetes*, and *diabetes lifestyle challenges*. As for symptoms of diabetes, maintaining blood glucose at a healthy level was reported by the highest number of participants. In addition, two participants mentioned foot health causing challenges or worry for them.

"Tingling and soreness in feet make movement challenging, the same pains make everyday tasks harder."

The most reported challenge in the treatment of diabetes was having to think about the diet, knowing what to eat, and remembering to do so regularly. Two of the participants also claimed it easy to forget to take their medication at times. Additionally, two of the participants reported diabetes requiring constant care causing them challenges and experiencing treatment fatigue due to it. Getting enough exercise was also challenging for two of the survey participants.

In addition, caring for diabetes can require expensive medicine, equipment and health appointments. Proper food can as well end up too expensive, especially if the diabetic is not familiar with healthy and diabetes-friendly options or does not enjoy cooking.

"Food as a whole is a challenge. I don't like cooking, I can't cook. I live alone. I have too little money."

Challenge	Mentions (n=17)
Challenges with keeping blood glucose balance	7
Diabetes forces you to think about your diet	6
Other health issues affect diabetes self-management	3

Table 6: Challenges in everyday diabetes self-management experienced by the survey participants (≥ 3 mentions)

The main challenge not directly caused by diabetes was lack of constant enough contact with health professionals. Two participants claimed being unable to see them often enough and the third one mentioned that even when they could, the professional would often be different from last time. In addition, other health issues that either hindered proper care for diabetes or plain made the disease worse were reported as challenges.

“It would be good to get to go to laboratory couple of times a year, and the doctor could contact me via digital channels if needed. Once a year is a long interval if the results fluctuate.”

The third challenge was the ignorance of other people: One participant stated that when visiting friends or attending events where food is served, they often had to either tell them about their disease and risk being stigmatized for it, or find a way to politely decline unhealthy snacks.

“The average person still has wrong information about diabetes. If I’m invited to visit and I tell about the disease, I’m given something tasteless without any sugar or salt with my coffee. If I don’t, I have to explain at the table, why I won’t take large amounts of all the seven kinds of sweet pastries.”

Other challenges mentioned by the participants included difficulties with weight control, accidentally injecting wrong amounts of insulin, and insulin freezing while the participant was visiting their cottage during winter.

Benefit	Mentions (n=31)
Booking appointments online	13
Checking laboratory reports	9
Using Omakanta	9
Checking doctor visit summaries	8
Checking and renewing prescriptions	8
Contacting the doctor	7
Looking for information about diabetes online	5
Ordering diabetes equipment online	5
Blood glucose results going automatically to doctor	3
No queuing	3
Providing and receiving peer support online	3

Table 7: Benefits using digital services and devices mentioned by the survey participants (≥ 3 mentions)

4.1.3 Benefits with the current eHealth services

The participants reported experiencing many benefits with the current services (Table 7). Specific features the participants mentioned as being useful were scheduling appointments, checking laboratory results, renewing prescriptions, checking visit summaries, ordering diabetes-supplies online, contacting doctors, and looking for information online. One participant also mentioned that digital services were cheaper or even free compared to non-digital ones, resulting in saving costs. Nine participants specifically mentioned using Omakanta, Finland’s online medical record service.

“It’s easy to check and renew prescriptions. It’s easy to check the laboratory results that also arrive quickly.”

“Renewing prescriptions, booking appointments to doctor and laboratory, checking the results, and messaging with the doctor. Looking for information online has also helped.”

One of the benefits experienced by the participants was automatic or at least digital sharing of blood glucose measurements with the health professionals. In the past, most diabetics have had to record their levels with pen and paper and physically carry them to their appointments, and some still have to do it. Compared to that, the participants with the option, found being able to either send the results via e-mail or even sync them automatically with the professionals much more useful. One participant also mentioned enjoying their laboratory results arriving straight to their mobile phone.

“Using the blood glucose sensor. The information can be seen right away from my own phone, and at the same time they get shared in the cloud with the healthcare organization. Handy and effortless.”

Digital health services also enabled taking care of their diabetes-related business on their own time without having to waste time queuing up or traveling for no real reason. One participant specifically mentioned enjoying being able to take their time and think carefully about their actions without anyone hurrying them while conducting their business online. Likewise, one mentioned that sometimes the appointments can feel rushed and it might be hard to remember the instructions the professional had given them. In those cases, they appreciated being able to check the report online afterwards.

“I am able to make my reservations in peace etc. and think carefully about my answers.”

“In the same way, I can find in Omakanta clarifications for my understandings of the treatment plans from my annual control visits or reception visits that have been slightly obscured by hurrying...”

One important feature of the digital health services was easy access to information. It was important to the participants to find general information related to diabetes, information related to the side effects caused by the disease, and new methods to deal with the disease. In addition, they enjoyed being able to find answers to the diabetes-related questions that might pop into their head without having to call or visit a professional.

“Diabeteskylä [a Finnish web portal for diabetes information] is my paramount support when I need information.”

Lastly, some of the participants mentioned that meeting other diabetics online was important to them. Digital platforms enabled having different peer-support groups where they could share their experiences, and finding help and helping others who were in the same situation with them. In addition, some of the participants were active in diabetes-related organizations. According to them, especially when the COVID-19 pandemic struck, being online meant having the means to continue participating actively in those.

“Experiences and comments from other diabetics.”

“Helping and instructing other type 2:s. I act as a peer support person online and I’m trained for it.”

4.1.4 Challenges with the current eHealth services

There were also some challenges the participants experienced with the current digital health services. The challenges varied from participant to participant even more than the benefits. Most of the participants claimed having used some digital services, however, three reported not knowing about them or being unable to find them. In

addition, one claimed not needing or being interested in digital services in the first place.

For those who used digital services, one of the challenges was the communication with professionals being spotty and slow. One participant complained that when contacting professionals, they would sometimes have to wait for an answer for very long times, if they would even get one in the first place. They also reported being often unsure if their message had been received at all, or what its status was.

“The response time to the digital services is long. The reply might come in a day or two weeks or only after asking about the same thing for a second time.”

Additionally, while the opportunities for peer-support were regarded as a good thing, one participant mentioned that sometimes people did not know what they were talking about, resulting in bad or even dangerous information.

Other issues the participants had faced were complicated services they did not know how to use, or services that simply did not work as expected. In addition, in some cases even when everything worked as expected, the information on the site had left a sour taste for them. For example, one participant reported feeling bad after seeing their disappointing lab results.

4.1.5 Needs and wants regarding eHealth services

As the eHealth services currently available for the participants differed greatly, so did their answers for future hopes (Table 8). Some participants wished for services that were already available for others.

Wish	Mentions (n=35)
Remote appointments to doctor	8
Being able to contact doctors online	5
Receiving instructions and counseling online	3

Table 8: Wishes expressed by the survey participants for better diabetes self-management (≥ 3 mentions)

The most common wish was being able to attend some of their diabetes nurse or doctor appointments remotely, at least in cases where being physically present was not required. In addition, some wished for short remote counseling sessions for quick questions or problems.

“I believe that some of the visits to diabetes nurse could be replaced with remote connections if the identification is trustworthy. Video connection could be enough for, for example, checking the feet as long as the suspicious cases would be called for face-to-face visits.”

Some also wished that they could communicate with the healthcare professionals online. Many participants could already receive messages from them, but sending messages back was not possible. This was found especially frustrating when there was a mistake in a prescription or visit report, and the participants had no easy way of correcting them.

“I wish that the Omakanta service was expanded so that as a patient I could message the doctors and nurses. Now I can’t tell them about, for example, prescriptions that have mistakes.”

The participants who had to record their blood glucose levels for the diabetes nurse but did not yet have a way of sending the results digitally also wished they could do so. Likewise, the participants who still had no way of receiving their laboratory results digitally generally wished to do so.

Some other wishes expressed by the participants were more information and counseling on nutrition as it is such an important part of diabetes care. In addition, one participant specifically mentioned wishing for more user testing with older adults, as often digital services were not designed to support, for example, weaker eyesight.

4.1.6 Peak experiences

Out of the participants, 20 reported having had a positive experience with digital diabetes services, while 7 reported having had a negative experience with them.

The question that asked about the situations where the services have been useful and the question asking for a positive experience resulted in slightly different answers. The second focused more on fastness, kind and smooth service, ease of use and not having to leave home, as opposed to the more functional elements (appointment booking, prescriptions and information) reported for the first question. The negative experiences focused on usability issues, slowness and bad information.

4.2 Interviews

This section first introduces the subset of survey participants that participated in the interviews. Then, the results obtained from the interviews will be presented.

As the topic was the same as in the survey, and all the interviewees were recruited from the survey participants, the results obtained from both were highly similar. However, due to the more in-depth nature of the interviews, they were able to provide some new findings as well as additional insight to the issues that had risen from the survey.

The interviewees varied in their level of education, diabetes treatment, and duration of diabetes. In addition, despite it not being asked in the interview, most of the interviewees mentioned their general location as well. Based on those mentions, it can be said that they also lived diversely around Finland.

Despite their variations in some areas, they seemed overall likely more active and ready to take more initiative than the average older adult with type 2 diabetes. This was already suggested by them being members of the Facebook group for type 2 diabetics where the survey was originally distributed. In addition, some of them mentioned being active in other associations as well, or participating in other studies. A few also mentioned taking initiative in finding out the emails of the nurses and doctors by guessing, and contacting them that way, thus showing a high level of initiative.

4.2.1 Participants

Out of the survey participants, 33 gave their consent for an interview invite and out of them a total of 8 participants (Table 9) sent their consent forms digitally and were able to be interviewed. The length of the interviews ranged from 25 minutes to 50 minutes with an average duration of 37.5 minutes. Out of the interviewees three were female and five male, aged between 65 and 80 and average age being 71 years old. Nearly all of the participants had at least vocational level education. One of the participants had received their diabetes diagnosis within a year, but excluding them, the duration of diabetes averaged at 18 years. Out of the 8 participants seven used medication, either insulin injections, tablets or both.

All of the interviewees reported using smart phones to at least some extent as they were convenient and easy to carry around. Some also reported using a tablet or a computer for longer tasks, or tasks that require more reading or writing, as the larger screen size and physical keyboard made using them easier than smaller devices.

The participants' overall attitude towards digital health services was positive or at least neutral, but with some reservations. All of them had used some digital health services and were generally interested in them, even if they were not completely comfortable with them.

4.2.2 Challenges in daily life

The interviewees reported several challenges (Table 11) and effects (Table 10) diabetes had on their daily lives. All of the interviewees who had had diabetes for over a year seemed to have good or at least sufficient diabetes self-management skills overall. They reported feeling that diabetes did not affect their daily lives too much, or they had already gotten used to it. They also felt they could manage it. However, they did

	Age	Gender	Education	Diabetes duration (y)	Treatment
P1	65 - 70	Male	Vocational	11 - 20	tablet(s) & insulin
P2	71 - 75	Male	Vocational	11 - 20	insulin
P3	76 - 80	Male	Bachelor's or equivalent	>20	insulin
P4	65 - 70	Female	Master's or equivalent	11 - 20	tablet(s)
P5	65 - 70	Female	Master's or equivalent	11 - 20	tablet(s) & insulin
P6	71 - 75	Female	Basic education	<1	tablet(s)
P7	65 - 70	Male	Master's or equivalent	3 - 10	diet
P8	65 - 70	Male	Vocational	>20	tablet(s) & insulin

Table 9: Background info of the interview participants (P1 - P8). Exact age and diabetes duration are concealed for privacy reasons.

Diabetes self-management experiences	Mentions (n=8)
Attitudes and experiences	
Diabetes does not affect life too much / used to it	7
Taking initiative with diabetes self-management	6
Gratitude and satisfaction with current status of diabetes	5
Being active in diabetes association activities etc.	4
Interest in diabetes information	4
Feeling that can make do with anything	3
Independence with diabetes self-management	3
Relaxed attitude towards diabetes self-management	3
Effects of diabetes on daily life	
Pill dispenser helps with diabetes self-management	6
Logging insulin injections and carbohydrates in notebook	4
Supporting and being supported by friends and family with diabetes issues	3
Strict daily routines	3
Measuring blood glucose multiple times a day	3
Diabetes forces you to take better care of your health	3

Table 10: Everyday diabetes self-management as experienced by the interviewees (≥ 3 mentions)

Challenge	Mentions (n=8)
Other health issues affect / are affected by diabetes self-management	5
Diabetes forces you to think about your diet	5
Worries about foot health	5
Worrying about other older adults and/or diabetics	5
Getting help with diabetes requires own initiative	4
Not receiving enough support from the healthcare system	4
Healthcare personnel are hard to reach	4
Exercising is difficult due to either physical challenges or availability	4
Diabetes appointments that feel unnecessary	4
Faulty, lacking, or otherwise burdensome equipment	3

Table 11: Challenges in everyday diabetes self-management experienced by the interviewees (≥ 3 mentions)

mention that even if they did not feel restricted by diabetes, it was still something they had to keep in mind constantly. Despite being generally confident with their diabetes self-management, a couple still expressed being a bit worried about the possibility of hypoglycemia.

“After all, I’m used to this [diabetes]. It is a thing that is a part of your life. I can’t really say it would limit you a great deal, but you have to keep it in mind.”

None of the participants mentioned diabetes equipment causing them any significant issues. However, they did speak about more minor challenges, such as having to remember to carry the equipment with them or to remember to order refills regularly. Sometimes faulty equipment could also cause additional work.

In the same way, a couple of the participants reported occasionally having troubles with either remembering to take their diabetes medication or taking it with them when going out, but it was not seen as a major issue. Almost all of the participants mentioned using a pill dispenser with their diabetes medication, and it was seen as a working solution.

“I have a pill dispenser that I charge with a week’s portions. It’s extremely good and works as a calendar at the same time.”

One of the most mentioned aspects of the daily lives of the interviewees was the diet required by diabetes. Challenges were reported with both what they could eat, but also scheduling their eating. Some either did not stress about it too much, or did not mind sticking to a strict diet. For others, it was a source of distress and challenges especially at the beginning of their diabetes as they had to learn new eating habits and to be mindful of their carbohydrate intake. However, as they lived with the disease, they reported becoming more accustomed to it.

“And then there is of course calculating and pondering the carbohydrates, these kinds of things are there of course.”

“Before, it was easy for me to eat low-fat foods and really healthy foods, but now I feel like it’s much more challenging cause you have to always be finding something to eat.”

As the participants were older adults, many of them had challenges getting enough exercise even if they wanted to due to non-diabetes related health issues. For example, musculoskeletal disorders common with older adults made movement difficult for some of them, preventing sufficient exercise. In addition, due to COVID-19 some exercise groups had been canceled. This, along with challenges with diabetes diet also contributed to challenges with weight management, which one of the participants mentioned. However, the interviewees did not feel like all of their other possible health issues affected their diabetes self-management. One even reported taking care of diabetes helped with some of them.

“As it is, I’ve had hip pain since fall, so my exercise is very poor and scarce. But I try to move anyway.”

A major concern for the interviewees was having a stable relationship with a diabetes nurse or doctor. Some reported having one and benefiting from the relationship, while others did not or mentioned changing doctors being a recurring issue among diabetics.

“And I won’t change my doctor anytime soon if I don’t have to. It is in a way always nicer to go to a doctor you know, and know it is easy to talk about anything.”

“...so I don’t have the problem many have that every time you go to see a doctor it’s a stranger there. This has been noted as a big problem in the Diabetesliitto-Facebook group as well. Many people complain that you have to explain everything from the beginning.”

Some also mentioned not receiving enough support from the healthcare system and being left too much on their own. However, two interviewees reported being in such a good situation with their diabetes that they felt their check-ups were not that useful. Access to the healthcare personnel seemed to have a large variation based on where in Finland the interviewees lived.

“Well, let’s say that it has come up on these courses as well that many diabetics have a regular relationship with a diabetes nurse, but here it seems to be quite feeble considering I have only had two appointments this whole time.”

Along with other health concerns, the interviewees were also worried about possible other health issues caused by diabetes. Especially feet were a cause of worry and concern for many of them. Furthermore, some reported it being hard to know on their own what symptoms were diabetes-related and what were not.

Benefit	Mentions (n=8)
Looking for information about diabetes online	5
Using email to contact diabetes nurse or doctor	4
Checking and renewing prescriptions online	4
Receiving peer support from social media	3
Communicating with diabetes nurse or doctor online (non-email)	3
Blood glucose graphs produced by diabetes apps	3
Using phone notifications for reminders for measuring blood glucose etc.	3
Sensor makes measuring blood glucose easier	3
Finding answers for questions that cause worry	3

Table 12: Benefits experienced using digital services and devices among the interviewees (≥ 3 mentions)

Managing diabetes requires effort from the afflicted, and based on the interviews, receiving help with diabetes requires taking your own initiative and being active as well. Some of the interviewees mentioned only getting appointments by demanding them, or having to be creative when figuring out how to contact health personnel.

“I know that people have situations that they have not had appointments in two years even. But I’ve tried to hold out.”

“This email, I just tried it. It wasn’t anywhere publicly at all. I just tried the doctors first and last name and [city name].fi and who would have thought, it worked and I got an answer.”

4.2.3 Benefits with the current eHealth services

The interviewees reported many benefits (Table 12) of the current eHealth services. Some of them were the same as with the larger survey group, but some only emerged during the interviews.

The most reported use case was looking for information about diabetes and diabetes diet online. Trustworthy websites, such as Duodecim Health Library (Kustannus Oy Duodecim, 2022), were seen as a good way to find answers to questions especially when they could not contact healthcare directly. One participant also mentioned looking up carbohydrate reference tables online.

“We can’t after all be or people can’t be constantly contacting them [healthcare] either, and the information needs to still be gained from somewhere, the internet is admittedly pretty good at that.”

Challenge	Mentions (n=8)
It's hard to read or write long texts on mobile	5
Digital diabetes services are hard to find	4
General usability issues	4
Need to be taught how to use new digital services	4
Learning to use new digital is challenging	3
Bad and false information about diabetes online	3

Table 13: Challenges with using digital services among the interviewees (≥ 3 mentions)

In addition, the interviewees who were able to contact either diabetes nurses or doctors digitally, for example by email, chat, or some other service, found them useful. The online contact methods made it possible for the participants to take care of their business on their own time, and gain answers to smaller questions easier and faster. Some participants reported using email to contact healthcare, even if it was forbidden or at least not recommended, because it was still easy to use and worked.

“So if we want a hassle-free and working communication, I think email is one of the best, because it leaves a documentation when writing, about what you have written, and it doesn't require both parties to be active at the same time.”

“I've been trying to tell others as well to use email, even though it's almost forbidden. I mean you're not really supposed to send these kinds of things there.”

Half of the interviewees also mentioned renewing and checking prescriptions in the Finnish health record Omakanta. One also mentioned checking the records of their visits to doctors there. Especially having prescriptions in Omakanta was seen as very useful.

Another benefit for digital services was finding and being able to give peer support with other diabetics online. However, as the treatment for type 2 diabetes varies from person to person, it was mentioned that some of the advice was not helpful. In fact, one interviewee mentioned that the advice meant for diabetics with dietary treatment could even be dangerous for diabetics on medication.

Some diabetics also have to order supplies, such as test strips, regularly. Some of the interviewees mentioned being able to take care of that effortlessly online. One interviewee especially appreciated that the service remembered their previous order, making it easy to send the same order repeatedly.

“So that works well, and the web page is even good in that way that it keeps the previous order topmost there, so you remember about pretty well -or see, what you have previously ordered, cause it's already there.”

A third of the interviewees had access to a diabetes sensor they could scan with

their phone. This helped them to track their blood glucose easier, and to share the results with their doctors easier either by exporting the generated report, or directly showing the results from their phone. One participant even had their blood glucose levels sync automatically to an online service they and their doctor could both access. Some of the interviewees reported using health applications on their mobile phones, for example for tracking activity levels. Some also used their phones for scanning their blood glucose. These apps were found useful or at the very least interesting by the users. The automatically generated graphs for blood glucose were rated especially useful. The interviewees who had access to those, stated they were simple to understand and helped to understand and manage their diabetes. In addition, they made it easier to share the results with doctors.

“It was so good the graphic that the doctor was delighted! They were easy to read, the doctor didn’t have to think or calculate things either.”

In addition to apps, some interviewees mentioned having timed notifications on their mobile phones to remember to measure their blood glucose or take their medication. For some, mobile phones were also a good way to receive notifications for, for example, ready laboratory results and arriving diabetes medication deliveries.

Besides using phones and applications, some of the interviewees also used other health technology, such as exercise bands or an Oura ring, which also had accompanying applications.

4.2.4 Challenges with the current eHealth services

The interviewees also reported some challenges regarding the current eHealth services (Table 13).

A major challenge with using digital health services was that the interviewees were not aware of their existence. According to them, finding information on the services was challenging and finding them randomly online even more so. Additionally, even when knowing about a service, searching for it online could still be a challenge if they could not remember the exact name. In addition, according to the interviewees, nurses and doctors did not usually mention digital services at all, if they even were aware of them.

“An hour wasn’t enough before I found my way there. I just could not use the right keywords.”

Enabler	Mentions (n=8)
Interest in remote appointments depending on issue	5
Interest in using health apps	4
Confidence in being able to use digital services after learning how to	4
Perceiving health apps useful or at least interesting	4
Using email without problems	4
Positive or neutral feeling about progress overall	4
Old work-related skills help with using digital services	4
Being told about a digital service by diabetes nurse	4
Being supported by friends and family with digital services	3
Using other commercial health tech	3

Table 14: Enablers for using digital services among the interviewees (≥ 3 mentions)

One interviewee also mentioned that sometimes they could see a notification for a received message but were not able to find it easily due to the service being too complicated to navigate. They also felt that the interface had no clear indicators of where the new message was. This caused them distress as they did not know if the message was about something important or urgent.

“I mean there are titles, you have messages and events and results, you never really know where exactly the thing is you are looking for. So, there should be some kind of a clear mark whether you have received a message or some results or something else. You have to always go through all of them to find where in there the new thing is!”

4.2.5 Enablers for using eHealth services

Not everyone is interested in using digital health services in the first place. In the survey, two participants stated not being interested in, or benefiting from the services in any way. In addition, it is likely that many people who think that way did not even reply to the survey. The participants who did use the services shared many common traits and conditions that seemed to imply potential as an eHealth user (Table 14).

Most of the interviewees were interested in remote appointments, albeit depending on the issue. Half also reported some level of interest in health apps, and were already using some, such as blood glucose sensor apps or general sport tracker apps. The participants who used them generally perceived them useful or at the very least interesting.

“I asked for something like this [diabetes apps] many years ago already after I had read from Diabetes magazine that these apps exist. So I asked from the diabetes association is there some for my phone.”

Wish	Mentions (n=8)
Digital services can not replace meeting doctor face to face	5
Having one person to contact about diabetes-related issues	3
Taking care of smaller issue via video appointment	3
One place for all diabetes-services	3
More comprehensive diabetes care (vs. taking care of separate issues)	3
Preferring face-to-face visits to doctor	3

Table 15: Wishes expressed by the interviewees for better diabetes self-management (≥ 3 mentions)

In general, even though some participants expressed the need for instruction with learning new digital services, they were confident in their ability to use basic digital services after teaching. Some of the participants mentioned their old work-related skills helping with using computers.

4.2.6 Needs and wants regarding eHealth services

Most of the interviewees saw internet and digital health services as interesting and useful supplements for diabetes and other health care. They also expressed some wishes for the future of the services (Table 15). Still, most felt that digital services cannot and should not replace traditional face-to-face care but support it. Especially being able to take care of smaller tasks and issues digitally was appreciated and wished for. However, for more important issues face-to-face meeting on site was strongly preferred. The interviewees wished for holistic diabetes care that considers them wholly instead of focusing on symptoms and felt that digital services were more about treating specific symptoms. They also mentioned that it was easier to talk about anything live, and the barrier to ask about things was higher digitally.

“These chats and emails can’t replace it, that you meet the doctor face-to-face and can see the situation.”

In addition, many of the interviewees wished for one diabetes contact, nurse or doctor, who they could turn to in all of their diabetes related matters. Likewise, many interviewees wished for one place they could find all the diabetes services available for them. Having such a place would also make it easier for everyone to learn how to use that one portal. Furthermore, some felt that currently the services are a bit all over the place.

“Since there are so many people for whom this digital thing is so hard. If there was somehow all this information under one link, so you wouldn’t have to collect it from all these different programs. I would imagine that I and many others who don’t use these services that much would be able to go there and find the information!”

For some of the interviewees using computers and digital services was self-evident. Especially those who had used similar services in their work prior to retiring did not report problems with them. However, most of the others reported it challenging to learn how to use new digital services. Some also mentioned many services being complicated and hard to use. Still, the overall opinion, even with the less digitally inclined, was that they could manage the basic tasks well enough, as long as someone taught them how to first. However, one participant mentioned that sometimes even understanding the instructions can be complicated.

“I am after all old enough to be a bit at loss with these computers. But after someone teaches me how, like this goes that way, I can do it.”

Despite their optimism on their own part, many of the interviewees expressed worry that even if they could handle the new digital services, they felt that other older adults might not be able to. In this regard, support from friends and family was important to the participants in learning and tackling digital services and devices as well. Many of the interviewees mentioned having a family member or a friend helping them with digital services.

“My aunt too lives nearby and says that she’s got this phone [senior phone] and she’s never used a computer I think, her son’s got one. But she says that she understands shi... none of that!”

Most of the interviewees had some experience with video calls from other areas of their life, but none had been offered a chance for video appointments as a part of diabetes care. Majority preferred having appointments live, but reported being interested in video appointments especially with lesser matters, or could think of situations where having a video appointment could be easier than a physical one. One participant stated being interested in video calls in some cases, but not being comfortable with discussing with a doctor via video call.

“Absolutely, absolutely. It’s the next step from phone calls. Video calls are handy if both ends can use them.”

“Yeeeah, I would be interested. Seeing the doctor that way when getting results for blood tests and something else, then sure I could speak with the doctor via remote connections too.”

Other wishes expressed by the interviewees consisted of having both blood glucose and injected insulin syncing automatically to the doctors, having clear and simple digital services, and overall doing more development work on diabetes services with diabetics.

5 Discussion

This chapter will review the results of the study by first discussing the answers to the research questions. Then, it'll move on to exploring the possible practical implications of the results, and also consider the limitations of this study. Finally, directions for future research will be proposed.

5.1 Answers to the research questions

This section takes another look at the results and the literature review, and then answers to the research questions based on them.

How does diabetes affect the lives of older adults with type 2 diabetes?

The amount and type of challenges experienced by the participants varied. In general, the participants were quite good at diabetes self-management and most had their disease under control. Most of them were quite satisfied, or at least used to their current situation, but even for them diabetes was something they had to keep in mind constantly. In addition, for many, diabetes required constant care in the form of taking medication, measuring blood glucose even multiple times a day, and thinking about diet. Thus, many also had to carry diabetes equipment, such as blood glucose sensor devices and insulin pens with them everywhere, and remember to order new equipment regularly.

The most reported challenges were controlling blood glucose, following a diabetes diet, and especially managing other health issues at the same time. These findings are in line with previous research (Pal et al., 2018). Diabetes also caused worries for many of the participants, either related to their own health or the health of the others. Particularly worries about foot health came up multiple times. Some participants mentioned having “small questions” that popped in their head and if not answered, started to grow into larger worries.

As type 2 diabetes is progressive and people typically have to live with it for decades, treatment fatigue has been shown to be a real issue (Adu et al., 2019). However, based on the results it seems that in the case the symptoms stay in control, living with diabetes for a long time can also result in it becoming so routine it actually reduces the treatment fatigue. In addition, although other health issues can make diabetes self-management more challenging, tasks such as taking medication can be done at the same time, reducing the mental load. However, diabetes self-management routinizing can cause problems when the daily routine is disturbed or, for example, by forgetting to take the medication.

Support from peers and family members was important for many of the participants, which is something that has been shown to be an enabler in successful diabetes self-management (Adu et al., 2019; Ranieri et al., 2021). Unfortunately, it might not be available to everyone, making support from other sources even more important.

Some of the older adults with type 2 diabetes are more active and independent in their life and diabetes self-management than others. Unfortunately, finding help with diabetes can require too much effort and own initiative for the less active patients. This can lead to unsuccessful diabetes self-management and further issues.

The results also suggest that good diabetes self-management skills enable and encourage independence and self-confidence regarding the disease, while more modest skills generate more anxiety and insecurity leading to a vicious circle. These findings are also in line with previous research that shows that the level of health and digital literacy have a significant effect on the success of the active aging of an older adult (Arcury et al., 2017; Eronen et al., 2019, 2021; Shan et al., 2019; Tirado-Morueta et al., 2018).

What benefits and challenges do the older adults with type 2 diabetes experience using the currently available eHealth services?

The participants reported the most benefits in taking care of their medical matters, such as booking appointments and renewing prescriptions, as well as looking for information, online. The participants who had the option also appreciated being able to contact their doctors online. Many also mentioned receiving and providing peer support online.

Apps and web services helped some participants to understand themselves and their diabetes better. Graphs and visualizations for blood glucose especially made it easier for them to understand and hence control the disease, which has also been shown before (Hall et al., 2015). The graphs not only helped the patients understand their blood glucose, but they were also significantly easier for the doctors to decode compared to numbers in a notebook. The graphs became even more useful when they were shared automatically with healthcare and the participant was able to receive feedback directly for them.

Among general usability issues that are applicable to any user group, the participants' main challenge with digital services was at first finding them, and then - for the participants who were less experienced with digital services - learning how to use them. This is also supported by previous research (Bhattacharjee et al., 2020; Ronda et al., 2014; Wildenbos et al., 2018). Healthcare professionals seemed to have struggled with using the services as well, as they had not really advertised them to the participants, or known how to use the services themselves. In addition, due to the nature of many digital services that focus more on symptoms, the participants felt that it was harder

to use them to get holistic care that considered them as a whole, and took into account the different aspects that might play into their disease.

Mobile phones were useful for the participants who used them, as they are easy to carry around and provide an opportunity to look for information or contact healthcare almost anywhere and anytime. In addition, they can contain useful apps or, for example, reminders for measuring blood glucose. However, the smaller screens made it harder for some of the participants to read or write longer texts. Furthermore, if the participant had an older model of the phone, some apps were not be available for them.

What needs and wants do older adults with type 2 diabetes have regarding eHealth services?

The need for support regarding diabetes can vary between patients and depending on the state of the disease. This resulted in some participants receiving too little support, while others had to go to appointments despite them feeling pointless. Therefore, diabetes care should be targeted more towards those who need it the most, while still keeping it available to all. However, the more independent patients could benefit from being able to conduct most of their diabetes matters online. Still, it was clear from the results that many of the participants did not wish for online services to completely replace the traditional appointments but to complement them.

Diabetes being in such a multi-faceted disease, the patients need to be taken into account as a whole instead of focusing on symptoms. This was especially true for the participants, many of whom had other medical issues as well that affected the management of their diabetes. They felt that digital healthcare can focus too much on single symptoms, while in face-to-face appointments it is easier to mention anything that might be related to diabetes. In addition, social aspects, such as peer-support, were important to many of the participants.

As diabetes requires constant care, it took a mental toll on some of the participants. Apps and services might have helped to mitigate that, by, for example, reminding of measuring blood glucose. Many of the participants also had to carry around diabetes equipment, which meant it had to be as easy as possible to carry with. In the future wearable technology could be beneficial, especially as many of the participants were already used to the concept since sensors are already mainstream in diabetes care.

5.2 Practical implications

First of all, the participants in this study were overall interested in eHealth solutions, meaning that *there is demand for them*.

Still, it was important for the participants that digital services would not completely replace meeting doctors face to face especially on the more important issues. However, many were interested in taking care of lesser issues digitally. Therefore, *the services should aim to supplement the existing health care services. They could focus especially on providing methods of finding answers to smaller questions that can arise in everyday life situations*.

Despite the interest, many participants reported either not knowing what services exist, or having trouble finding even the ones they did know exist. In addition, one participant mentioned not only the digital diabetes services, but the current diabetes services as a whole feeling a bit like a miscellaneous patchwork instead of a coherent unit. While a “super-service” that would combine all diabetes services for everyone is likely unrealistic, *a diabetes portal that could collect links to other resources would be beneficial*. In addition, *the healthcare system could promote the existing services more*. The participants also wished for ways to contact healthcare with smaller matters more easily. Thus, *services providing easy access to healthcare with small diabetes-related questions would likely be well received*.

Digital services in general should be made as simple as possible to improve their overall usability. In addition, *instruction for using them should be more accessible*. That seemed to be very important, as not every older adult can be expected to have a friend or a family member to help them with digital services.

For many diabetics, measuring blood glucose is a daily event and thus there are already solutions for automating the process of sharing the information with doctors (Sensotrend Oy, 2020), and based on the results of this survey the services are well liked. However, insulin inputs still have to be reported by hand, which exposes them for human error. Insulin memory pens can help mitigate the effect, but it could be improved by automating the process further. *Automatization of measuring and reporting blood glucose should be made available for more diabetics*. Additionally, *insulin pens that automatically log the amounts to a service could be helpful*.

Social aspects, such as finding new friends and both receiving and providing peer support with digital devices and diabetes came up during the research. To cater for these needs, *there could be platforms to facilitate people meeting each other and sharing experiences*. However, these should be moderated somehow to avoid spreading false information either accidentally or intentionally.

Difficulties in knowing what to eat and when came up in the study as well. A couple of participants mentioned that they had to completely re-learn what kind of food was considered healthy and suitable for the diabetes diet. Even though

there is information on the diabetes nutrition online, *services for easy and practical information for diabetes diet, for example simple recipes, could help many.*

Many interviewees mentioned using email or it being a familiar method for them. *EHealth services could capitalize on the pre-existing skills of the users, by creating their messaging user interfaces to resemble general email interfaces to allow for easy learnability.* In addition, this utilization of the users' previous knowledge in the design process could be extrapolated to other aspects of the services as well.

For the older adults with very little experience with digital services, even understanding instructions for them can be challenging. On the other hand, many older adults have some experience using digital devices due to their previous work experience and do not encounter problems with the services. *Peer-teaching within older adults could be a good way to increase the digital literacy of some of the older adults while supporting the social aspects of their disease management as well.*

5.3 Limitations

The main limitation of this research was its limited pool of participants. Due to time constraints, as well as the still ongoing COVID-19 pandemic, all of the participants were recruited online from a Facebook group for type 2 diabetics managed by the Finnish Diabetes Association. This already limited the scope to the older adults that had joined the Finnish Diabetes Association and had enough digital skills and interest to be in the group. Ideally, the same survey could have been distributed offline as well, for example through diabetes nurses or pharmacies, to reach the rest of the target group. Unfortunately, due to the time and resource constraints, that was impossible.

In addition, especially the people who participated in the interviews, ended up mainly being relatively highly educated, motivated to manage their diabetes, and for the most part had their diabetes under control. This is unlikely true for every older adult with type 2 diabetes, so the results will naturally not reflect every experience. However, although the participants turned up to be mostly what could be described as an "expert group", their contribution was still important. On the other hand, they displayed the benefits less experienced groups could enjoy in the future, and on the other they highlighted the challenges the less experienced will definitely run into in the future if they are not addressed before that.

The interviews were also conducted completely remotely to ensure the safety of the participants, as they had a high risk of a serious COVID-19 infection. As the interviews were held on phone, visual cues could not be read and it is possible that it affected the analysis. It is also possible that it made it more challenging to build trust which could have resulted in less data. On the other hand, phone interviews enabled older adults from all over Finland to participate, resulting in a less biased

sample in that regard.

The analysis was also done by only one person due to the nature of the study. Multiple people analyzing the data could have produced more profound results.

The SILS health literacy assessing question was translated to Finnish by an amateur, as currently there is no tested Finnish translation for it. Therefore it is possible, that it did not work as intended, but for the purposes of this thesis, it presumably had adequate accuracy.

5.4 Future research

The target group within type 2 diabetics was really wide, being limited only by age. Within the participants there were people who used daily insulin injections, and people who did not need any medication. Further studies should be done on, for example, examining what needs specifically the type 2 diabetics who require insulin injections have, and how they might differ from type 1 diabetics. In addition, as most of the replies in this study came from people under 76 years old, researching how people older than that perceive eHealth services could produce more results.

Two of the participants also specifically mentioned Maisa, the new health portal used in the Helsinki area, being complicated to use. As it is being used by many, it would be beneficial to research its usability.

One interviewee spoke about their experiences with treating their diabetes with diet alone, and expressed feeling like the concerns of the diabetics with no medication were often not taken seriously. Concerns about diet were also something that came up several times during the study. Therefore, the specific experiences related to treating diabetes with diet alone might also be useful to study further, especially as that might tie into helping to prevent the onset of the disease too.

Despite it being out of the scope for this thesis, this research also ended up producing some amount of data specifically about the emotions and attitudes the older adults had towards the digital services and diabetes self-management. Snippets of it were included in the results, but it was not discussed deeply. In the future, studies focused on that could produce important results.

6 Conclusion

The topic of this study was exploring and identifying the needs of the older adults with type 2 diabetes regarding eHealth services to facilitate easier self-management of the disease. The research approached this by examining what challenges older adults face in their diabetes self-management, what benefits and challenges they experience using the current eHealth services, and what wishes and needs they have for the future ones. The research was conducted as an explorative mixed-methods study and included an online survey with both multiple choice and open questions and semi-structured phone interviews. In total, 35 people participated in the survey, eight of whom were interviewed.

The participants of this study were generally satisfied with their diabetes self-management and had their disease under control, but many hoped for more opportunities to carry out diabetes-related tasks remotely. However, at the same time they wished that online services would not replace the traditional ones, but would complement them. Many participants wished for more support, and based on the results, finding it required significant amounts of own initiative.

The most mentioned benefits in eHealth services were being able to book appointments online, finding information, and using Omakanta services. The most mentioned challenges on the other hand, were finding the services, and learning how to use them. Nonetheless, overall, the participants were confident in their ability to use them at least after being taught.

The study revealed several challenges, benefits, and needs the older adults with type 2 diabetes have in their life regarding eHealth services. Additionally, this study provided suggestions for practical implications the results might have. The results and suggestions provide directions to what kinds of eHealth services the target group benefits from and how they should be developed, as well as suggestions for future studies.

Most of the participants of this study were satisfied with the control of their diabetes and were relatively confident in their digital skills. In the future, it might be beneficial to focus also on the less skilled and confident type 2 diabetics. In addition, as the interviews emphasized, type 2 diabetics can have very different needs depending on their treatment methods. Therefore, focusing on, for example, the type 2 diabetics who survive on diet alone might be valuable.

References

- Abbott. (2021). *Freestyle librelink*. Retrieved July 9, 2022, from <https://www.freestyle.abbott/za-en/product/freestyle-libre-link.html>
- Adam, L., O'Connor, C., & Garcia, A. C. (2018). Evaluating the Impact of Diabetes Self-Management Education Methods on Knowledge, Attitudes and Behaviours of Adult Patients With Type 2 Diabetes Mellitus. *Canadian Journal of Diabetes*, *42*(5), 470–477.e2. <https://doi.org/10.1016/j.jcjd.2017.11.003>
- Adu, M. D., Malabu, U. H., Malau-Aduli, A. E. O., & Malau-Aduli, B. S. (2019). Enablers and barriers to effective diabetes self-management: A multi-national investigation. *PLOS ONE*, *14*(6), e0217771. <https://doi.org/10.1371/journal.pone.0217771>
- Al Sayah, F., Williams, B., & Johnson, J. (2012). Measuring Health Literacy in Individuals With Diabetes. *Health education & behavior: the official publication of the Society for Public Health Education*, *40*. <https://doi.org/10.1177/1090198111436341>
- Andrews, J. A., Brown, L. J., Hawley, M. S., & Astell, A. J. (2019). Older Adults' Perspectives on Using Digital Technology to Maintain Good Mental Health: Interactive Group Study. *Journal of Medical Internet Research*, *21*(2), e11694. <https://doi.org/10.2196/11694>
- Arambepola, C., Ricci-Cabello, I., Manikavasagam, P., Roberts, N., French, D. P., & Farmer, A. (2016). The Impact of Automated Brief Messages Promoting Lifestyle Changes Delivered Via Mobile Devices to People with Type 2 Diabetes: A Systematic Literature Review and Meta-Analysis of Controlled Trials. *Journal of Medical Internet Research*, *18*(4), e86. <https://doi.org/10.2196/jmir.5425>
- Arcury, T. A., Quandt, S. A., Sandberg, J. C., Miller, D. P., Latulipe, C., Leng, X., Talton, J. W., Melius, K. P., Smith, A., & Bertoni, A. G. (2017). Patient Portal Utilization Among Ethnically Diverse Low Income Older Adults: Observational Study. *JMIR medical informatics*, *5*(4), e47. <https://doi.org/10.2196/medinform.8026>
- ATLAS.ti. (2022). *Atlas.ti* (Version 8.4.5). <https://www.atlasti.com/>
- Audacity Team. (2022). *Audacity®: Free audio editor and recorder* (Version 3.1.3). <https://audacityteam.org/>
- Aula, A. (2005). User study on older adults' use of the Web and search engines. *Universal Access in the Information Society*, *4*(1), 67–81. <https://doi.org/10.1007/s10209-004-0097-7>
- Azevedo, V., Carvalho, M., Costa, F., Mesquita, S., Soares, J., Teixeira, F., & Maia, Â. (2017). Interview transcription: Conceptual issues, practical guidelines, and challenges. *Revista de Enfermagem Referência, IV Série*, 159–168. <https://doi.org/10.12707/RIV17018>

- Bhattacharjee, P., Baker, S., & Waycott, J. (2020). Older adults and their acquisition of digital skills: A review of current research evidence. *32nd Australian Conference on Human-Computer Interaction*, 437–443. <https://doi.org/10.1145/3441000.3441053>
- Biduski, D., Bellei, E. A., Rodriguez, J. P. M., Zaina, L. A. M., & De Marchi, A. C. B. (2020). Assessing long-term user experience on a mobile health application through an in-app embedded conversation-based questionnaire. *Computers in Human Behavior*, *104*, 106169. <https://doi.org/10.1016/j.chb.2019.106169>
- Broekhuis, M., van Velsen, L., ter Stal, S., Weldink, J., & Tabak, M. (2019). Why My Grandfather Finds Difficulty in using Ehealth: Differences in Usability Evaluations between Older Age Groups, 48–57. <https://doi.org/10.5220/0007680800480057>
- Clarke, V., & Braun, V. (2017). Thematic analysis. *The Journal of Positive Psychology*, *12*(3), 297–298. <https://doi.org/10.1080/17439760.2016.1262613>
_eprint: <https://doi.org/10.1080/17439760.2016.1262613>
- Comincioli, E., Chirico, A., Gaggioli, A., & Masoodian, M. (2021). The Need for a Paradigm Shift in Approaching Ageing-Related Design Research and Practice. *Frontiers in Psychology*, *12*. Retrieved February 28, 2022, from <https://www.frontiersin.org/article/10.3389/fpsyg.2021.750178>
- Corp, I. (2020). *Ibm spss statistics for macintosh* (Version 27.0). <https://www.ibm.com/products/spss-statistics>
- Cotten, S. R. (2017). Examining the Roles of Technology in Aging and Quality of Life. *The Journals of Gerontology: Series B*, *72*(5), 823–826. <https://doi.org/10.1093/geronb/gbx109>
- Davies, M. J., D'Alessio, D. A., Fradkin, J., Kernan, W. N., Mathieu, C., Mingrone, G., Rossing, P., Tsapas, A., Wexler, D. J., & Buse, J. B. (2018). Management of Hyperglycemia in Type 2 Diabetes, 2018. A Consensus Report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). *Diabetes Care*, *41*(12), 2669–2701. <https://doi.org/10.2337/dci18-0033>
- Dehong, F., Mayer, H., & Kober, J. (2019). Real-World Assessments of mySugr Mobile Health App. *Diabetes Technology & Therapeutics*, *21*(S2), S2–35. <https://doi.org/10.1089/dia.2019.0019>
- DigiIN. (2021). *Project info*. Retrieved January 19, 2022, from <https://digiin.fi/en/consortium-and-partners>
- Ellahham, S. (2020). Artificial Intelligence: The Future for Diabetes Care. *The American Journal of Medicine*, *133*(8), 895–900. <https://doi.org/10.1016/j.amjmed.2020.03.033>
- Eriksson-Backa, K., Hirvonen, N., Enwald, H., & Huvila, I. (2021). Enablers for and barriers to using My Kanta – A focus group study of older adults' perceptions of th, 14.

Eronen, J., Paakkari, L., Portegijs, E., Saajanaho, M., & Rantanen, T. (2019). Assessment of health literacy among older Finns. *Aging Clinical and Experimental Research*, *31*(4). <https://doi.org/10.1007/s40520-018-1104-9>

Accepted: 2019-04-04T09:56:34Z

Eronen, J., Paakkari, L., Portegijs, E., Saajanaho, M., & Rantanen, T. (2021). Health literacy supports active aging. *Preventive Medicine*, *143*, 106330. <https://doi.org/10.1016/j.ypmed.2020.106330>

European Commission. (2017). *Standard eurobarometer 87*. Directorate-General for Communication. Retrieved June 19, 2022, from http://data.europa.eu/88u/dataset/S2142_87_3_STD87_ENG

Finbråten, H. S., Wilde-Larsson, B., Nordström, G., Pettersen, K. S., Trollvik, A., & Guttersrud, Ø. (2018). Establishing the HLS-Q12 short version of the European Health Literacy Survey Questionnaire: Latent trait analyses applying Rasch modelling and confirmatory factor analysis. *BMC Health Services Research*, *18*(1), 506. <https://doi.org/10.1186/s12913-018-3275-7>

Furstrand, D., & Kayser, L. (2015). Development of the eHealth Literacy Assessment Toolkit, eHLA. *MEDINFO 2015: eHealth-enabled Health*, 971–971. <https://doi.org/10.3233/978-1-61499-564-7-971>

Hall, A. K., Bernhardt, J. M., Dodd, V., & Vollrath, M. W. (2015). The Digital Health Divide: Evaluating Online Health Information Access and Use Among Older Adults. *Health Education & Behavior*, *42*(2), 202–209. <https://doi.org/10.1177/1090198114547815>

Heponiemi, T., Kaihlanen, A. M., Kouvonen, A., Leemann, L., Taipale, S., & Gluschkoff, K. (2022). The role of age and digital competence on the use of online health and social care services: A cross-sectional population-based survey. *Digit Health*, *8*. <https://doi.org/https://doi.org/10.1177/20552076221074485>

Hoogenbosch, B., Postma, J., de Man-van Ginkel, J. M., Tiemessen, N. A., van Delden, J. J., & van Os-Medendorp, H. (2018). Use and the Users of a Patient Portal: Cross-Sectional Study. *Journal of Medical Internet Research*, *20*(9), e262. <https://doi.org/10.2196/jmir.9418>

Hunt, C. W. (2015). Technology and diabetes self-management: An integrative review. *World Journal of Diabetes*, *6*(2), 225–233. <https://doi.org/10.4239/wjd.v6.i2.225>

International Diabetes Federation. (2021). *Diabetes facts and figures*. Retrieved January 19, 2022, from <https://idf.org/aboutdiabetes/what-is-diabetes/facts-figures.html>

Jeppesen, K. M., Coyle, J. D., & Miser, W. F. (2009). Screening Questions to Predict Limited Health Literacy: A Cross-Sectional Study of Patients With Diabetes Mellitus. *The Annals of Family Medicine*, *7*(1), 24–31. <https://doi.org/10.1370/afm.919>

- Juul, L., Rowlands, G., & Maindal, H. T. (2018). Relationships between health literacy, motivation and diet and physical activity in people with type 2 diabetes participating in peer-led support groups. *Primary Care Diabetes*, *12*(4), 331–337. <https://doi.org/10.1016/j.pcd.2018.02.005>
- Kallio, H., Pietilä, A.-M., Johnson, M., & Kangasniemi, M. (2016). Systematic methodological review: Developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing*, *72*(12), 2954–2965. <https://doi.org/10.1111/jan.13031>
_eprint: <https://onlinelibrary.wiley.com/doi/pdf/10.1111/jan.13031>
- Kanta Services. (2022). *My kanta statistics*. Retrieved July 9, 2022, from <https://www.kanta.fi/en/statistics>
- Karapanos, E., Zimmerman, J., Forlizzi, J., & Martens, J.-B. (2010). Measuring the dynamics of remembered experience over time. *Interacting with Computers*, *22*(5), 328–335. <https://doi.org/10.1016/j.intcom.2010.04.003>
- Karapanos, E., Zimmerman, J., Forlizzi, J., & Martens, J.-b. (2009). User experience over time: An initial framework. *IEEE Journal of Solid-state Circuits - IEEE J SOLID-STATE CIRCUITS*, 729–738. <https://doi.org/10.1145/1518701.1518814>
- Karisalmi, N., Kaipio, J., & Kujala, S. (2019). Encouraging the Use of eHealth Services: A Survey of Patients' Experiences. *Studies in Health Technology and Informatics*, *257*, 206–211.
- Karnoe, A., Furstrand, D., Christensen, K. B., Norgaard, O., & Kayser, L. (2018). Assessing Competencies Needed to Engage With Digital Health Services: Development of the eHealth Literacy Assessment Toolkit. *Journal of Medical Internet Research*, *20*(5), e178. <https://doi.org/10.2196/jmir.8347>
- Kaur, P., Stoltzfus, J., & Yellapu, V. (2018). Descriptive statistics. *International Journal of Academic Medicine*, *4*(1), 60. https://doi.org/10.4103/IJAM.IJAM_7_18
- Kirley, K., & Sachdev, N. (2018). Digital Health–Supported Lifestyle Change Programs to Prevent Type 2 Diabetes. *Diabetes Spectrum*, *31*(4), 303–309. <https://doi.org/10.2337/ds18-0019>
- Koponen, A., Simonsen-Rehn, N., & Suominen, S. (2016). Determinants of physical activity among patients with type 2 diabetes: The role of perceived autonomy support, autonomous motivation and self-care competence. *Psychology, Health & Medicine*, *22*, 1–13. <https://doi.org/10.1080/13548506.2016.1154179>
- Koski, S. (2021). *Diabetesbarometri 2021 [diabetes barometer 2021]*. Finnish Diabetes Association. Retrieved January 18, 2022, from https://www.diabetes.fi/files/21805/Diabetesbarometri_2021.pdf
- Kujala, S., & Miron-Shatz, T. (2013). Emotions, experiences and usability in real-life mobile phone use. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 1061–1070. <https://doi.org/10.1145/2470654.2466135>

- Kustannus Oy Duodecim. (2022). *Duodecim terveyskirjasto*. Retrieved June 22, 2022, from www.terveyskirjasto.fi
- Lee, E.-H., Lee, Y. W., Lee, K.-W., Nam, M., & Kim, S. H. (2018). A new comprehensive diabetes health literacy scale: Development and psychometric evaluation. *International Journal of Nursing Studies*, *88*, 1–8. <https://doi.org/10.1016/j.ijnurstu.2018.08.002>
- Mannheim, I., Schwartz, E., Xi, W., Buttigieg, S. C., McDonnell-Naughton, M., Wouters, E. J. M., & van Zaanen, Y. (2019). Inclusion of Older Adults in the Research and Design of Digital Technology. *International Journal of Environmental Research and Public Health*, *16*(19), 3718. <https://doi.org/10.3390/ijerph16193718>
- Microsoft Corporation. (2022). *Microsoft Excel* (Version 2019 (16.60)). <https://office.microsoft.com/excel>
- Morris, N. S., MacLean, C. D., Chew, L. D., & Littenberg, B. (2006). The Single Item Literacy Screener: Evaluation of a brief instrument to identify limited reading ability. *BMC Family Practice*, *7*(1), 21. <https://doi.org/10.1186/1471-2296-7-21>
- Muellmann, S., Forberger, S., Möllers, T., Bröring, E., Zeeb, H., & Pischke, C. R. (2018). Effectiveness of eHealth interventions for the promotion of physical activity in older adults: A systematic review. *Preventive Medicine*, *108*, 93–110. <https://doi.org/10.1016/j.ypmed.2017.12.026>
- Musselwhite, K., Cuff, L., McGregor, L., & King, K. M. (2007). The telephone interview is an effective method of data collection in clinical nursing research: A discussion paper. *International Journal of Nursing Studies*, *44*(6), 1064–1070. <https://doi.org/10.1016/j.ijnurstu.2006.05.014>
- Nathan, D. M., Buse, J. B., Davidson, M. B., Ferrannini, E., Holman, R. R., Sherwin, R., Zinman, B., Association, A. D., & for Study of Diabetes, E. A. (2009). Medical management of hyperglycemia in type 2 diabetes: A consensus algorithm for the initiation and adjustment of therapy: A consensus statement of the american diabetes association and the european association for the study of diabetes. *Diabetes Care*, *32* Suppl 1, 389–405. <https://doi.org/10.2337/dc08-9025>
- Newell, A. F. (2011). Design and the Digital Divide: Insights from 40 Years in Computer Support for Older and Disabled People. *Synthesis Lectures on Assistive, Rehabilitative, and Health-Preserving Technologies*, *1*(1), 83–105, 145–151. <https://doi.org/10.2200/S00369ED1V01Y201106ARH001>
- Niedorys-Karczmarczyk, B., Chrzan-Rodak, A., & Slusarska, B. (2020). Health Literacy – a review of research using the European Health Literacy Questionnaire (HLS-EU-Q16) in 2010-2018. *Pielęgniarstwo XXI wieku / Nursing in the 21st Century*, *19*. <https://doi.org/10.2478/pielxxiw-2020-0001>
- O'Connor, S., Hanlon, P., O'Donnell, C. A., Garcia, S., Glanville, J., & Mair, F. S. (2016). Understanding factors affecting patient and public engagement and recruitment to digital health interventions: A systematic review of qualitative studies.

BMC Medical Informatics and Decision Making, 16(1), 120. <https://doi.org/10.1186/s12911-016-0359-3>

Oh, S. S., Kim, K.-A., Kim, M., Oh, J., Chu, S. H., & Choi, J. (2021). Measurement of Digital Literacy Among Older Adults: Systematic Review. *Journal of Medical Internet Research*, 23(2), e26145. <https://doi.org/10.2196/26145>

Olphert, C. W., Damodaran, L., & May, A. J. (2005). Towards digital inclusion – engaging older people in the ‘digital world’. <https://doi.org/10.14236/ewic/AD2005.17>

Osborn, C. Y., Mayberry, L. S., Mulvaney, S. A., & Hess, R. (2010). Patient web portals to improve diabetes outcomes: A systematic review. *Current diabetes reports*, 10(6), 422–435. <https://doi.org/10.1007/s11892-010-0151-1>

Pacaud, D., Kelley, H., Downey, A. M., & Chiasson, M. (2012). Successful Delivery of Diabetes Self-Care Education and Follow-Up through eHealth Media. *Canadian Journal of Diabetes*, 36(5), 257–262. <https://doi.org/10.1016/j.jcjd.2012.08.006>

Pal, K., Dack, C., Ross, J., Michie, S., May, C., Stevenson, F., Farmer, A., Yardley, L., Barnard, M., & Murray, E. (2018). Digital Health Interventions for Adults With Type 2 Diabetes: Qualitative Study of Patient Perspectives on Diabetes Self-Management Education and Support. *Journal of Medical Internet Research*, 20(2), e8439. <https://doi.org/10.2196/jmir.8439>

Pangrazio, L., Godhe, A.-L., & Ledesma, A. G. L. (2020). What is digital literacy? a comparative review of publications across three language contexts. *E-Learning and Digital Media*, 17(6), 442–459. <https://doi.org/10.1177/2042753020946291>

Park, S., & Kim, B. (2020). Readiness for utilizing digital intervention: Patterns of internet use among older adults with diabetes. *Primary Care Diabetes*, 14(6), 692–697. <https://doi.org/10.1016/j.pcd.2020.08.005>

Ramadas, A., Quek, K. F., Chan, C. K. Y., & Oldenburg, B. (2011). Web-based interventions for the management of type 2 diabetes mellitus: A systematic review of recent evidence. *International Journal of Medical Informatics*, 80(6), 389–405. <https://doi.org/10.1016/j.ijmedinf.2011.02.002>

Ranieri, J., Guerra, F., Angione, A. L., Di Giacomo, D., & Passafiume, D. (2021). Cognitive Reserve and Digital Confidence among Older Adults as New Paradigm for Resilient Aging. *Gerontology and Geriatric Medicine*, 7, 2333721421993747. <https://doi.org/10.1177/2333721421993747>

Roche Diagnostics. (2022). *Mysugr*. Retrieved July 9, 2022, from <https://www.mysugr.com/en/>

Roglic, G. (2016). *WHO Global report on diabetes: A summary*. Retrieved July 10, 2022, from <https://www.ijncd.org/article.asp?issn=2468-8827;year=2016;volume=1;issue=1;spage=3;epage=8;aulast=Roglic;type=3>

- Ronda, M. C. M., Dijkhorst-Oei, L.-T., & Rutten, G. E. H. M. (2014). Reasons and barriers for using a patient portal: Survey among patients with diabetes mellitus. *Journal of Medical Internet Research*, *16*(11), e263. <https://doi.org/10.2196/jmir.3457>
- Rumbold, J. M. M., O’Kane, M., Philip, N., & Pierscionek, B. K. (2020). Big Data and diabetes: The applications of Big Data for diabetes care now and in the future. *Diabetic Medicine*, *37*(2), 187–193. <https://doi.org/10.1111/dme.14044>
_eprint: <https://onlinelibrary.wiley.com/doi/pdf/10.1111/dme.14044>
- Sahin, C., & Naylor, P.-J. (2017). Mixed-Methods Research in Diabetes Management via Mobile Health Technologies: A Scoping Review. *JMIR Diabetes*, *2*(1), e6667. <https://doi.org/10.2196/diabetes.6667>
- Sensotrend Oy. (2020). *Sensotrend*. Retrieved July 9, 2022, from <https://www.sensotrend.fi/connect/welcome>
- Shan, R., Sarkar, S., & Martin, S. S. (2019). Digital health technology and mobile devices for the management of diabetes mellitus: State of the art. *Diabetologia*, *62*(6), 877–887. <https://doi.org/10.1007/s00125-019-4864-7>
- Siren, A., & Knudsen, S. G. (2017). Older Adults and Emerging Digital Service Delivery: A Mixed Methods Study on Information and Communications Technology Use, Skills, and Attitudes. *Journal of Aging & Social Policy*, *29*(1), 35–50. <https://doi.org/10.1080/08959420.2016.1187036>
_eprint: <https://doi.org/10.1080/08959420.2016.1187036>
- Sorensen, K., Van den Broucke, S., Fullam, J., Doyle, G., Pelikan, J., & Slonska, Z. (2012). Health literacy and public health: A systematic review and integration of definitions and models. *BioMed Central Public Health*, *25*, 12–80.
- Sørensen, K., Van den Broucke, S., Pelikan, J. M., Fullam, J., Doyle, G., Slonska, Z., Kondilis, B., Stoffels, V., Osborne, R. H., & Brand, H. (2013). Measuring health literacy in populations: Illuminating the design and development process of the European Health Literacy Survey Questionnaire (HLS-EU-Q). *BMC Public Health*, *13*(1), 948. <https://doi.org/10.1186/1471-2458-13-948>
- The Social Insurance Institution of Finland. (2020). *Existing, new and withdrawn entitlements to reimbursement of drug expenses 2019–*. Retrieved January 20, 2022, from <https://www.kela.fi/web/en/statistical-database-kelasto>
- Tirado-Morueta, R., Aguaded-Gómez, J. I., & Hernando-Gómez, Á. (2018). The socio-demographic divide in Internet usage moderated by digital literacy support. *Technology in Society*, *55*, 47–55. <https://doi.org/10.1016/j.techsoc.2018.06.001>
- Valkonen, P., Karisalmi, N., Kaipio, J., & Kujala, S. (2021). 'remote interviews and visual timelines with patients: Lessons learned. *Stud Health Technol Inform*, *281*, 845–849. <https://doi.org/10.3233/SHTI210298>

- Vasilescu, M. D., Serban, A. C., Dimian, G. C., Aceleanu, M. I., & Picatoste, X. (2020). Digital divide, skills and perceptions on digitalisation in the European Union—Towards a smart labour market. *PLOS ONE*, *15*(4), e0232032. <https://doi.org/10.1371/journal.pone.0232032>
- Vehko, T., Ruotsalainen, S., & Hyppönen, H. (2019). *E-health and e-welfare of Finland : Check Point 2018*. THL. Retrieved March 7, 2022, from <https://www.julkari.fi/handle/10024/138244>
Accepted: 2019-06-11T05:03:38Z
- Vermunt, P. W., Milder, I. E., Wielaard, F., Baan, C. A., Schelfhout, J. D., Westert, G. P., & van Oers, H. A. (2012). Implementation of a lifestyle intervention for type 2 diabetes prevention in Dutch primary care: Opportunities for intervention delivery. *BMC Family Practice*, *13*(1), 79. <https://doi.org/10.1186/1471-2296-13-79>
- Ware, P., Bartlett, S. J., Paré, G., Symeonidis, I., Tannenbaum, C., Bartlett, G., Poissant, L., & Ahmed, S. (2017). Using eHealth Technologies: Interests, Preferences, and Concerns of Older Adults. *Interactive Journal of Medical Research*, *6*(1), e4447. <https://doi.org/10.2196/ijmr.4447>
- Webropol.fi. (2022). *Webropol*. Retrieved January 20, 2022, from <https://webropol.fi/>
- Wildenbos, G. A., Jaspers, M. W. M., Schijven, M. P., & Dusseljee- Peute, L. W. (2019). Mobile health for older adult patients: Using an aging barriers framework to classify usability problems. *International Journal of Medical Informatics*, *124*, 68–77. <https://doi.org/10.1016/j.ijmedinf.2019.01.006>
- Wildenbos, G. A., Peute, L., & Jaspers, M. (2018). Aging barriers influencing mobile health usability for older adults: A literature based framework (mold-us). *International Journal of Medical Informatics*, *114*. <https://doi.org/10.1016/j.ijmedinf.2018.03.012>
- Williams, M., & Moser, T. (2019). The Art of Coding and Thematic Exploration in Qualitative Research. *undefined*. Retrieved July 24, 2022, from <https://www.semanticscholar.org/paper/The-Art-of-Coding-and-Thematic-Exploration-in-Williams-Moser/c0a0c26ac41cb8beb337834e6c1e2f35b91d071d>
- Ypsomed AG. (2022). *MyLife diabetes care international*. Retrieved July 9, 2022, from <https://www.mylife-diabetescare.com/>

Appendix A: Survey in English

For the purposes of this thesis, this is an English translation of the original survey that was in Finnish. The questions for health literacy and digital literacy were translated to Finnish from the original tools by the author of this thesis. Some of the questions were asked only if the participant answered in a particular way before.



Digital health services in the self-management of type 2 diabetes for 65+ older adults

As background information, we first ask about your experiences with reading health information and using smart devices.

Choose the option that best describes your situation

	Never	Rarely	Sometimes	Often	Always
How often do you need to have someone help you when you read instructions, pamphlets, or other written material from your doctor or pharmacy? The material can be, for example, digital or on paper.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How confident do you feel..?

	Not confident at all	Not very confident	Pretty confident	Completely confident
Using a computer in general?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Using touchscreen (for example in mobile phones or tablet computers)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Finding information online?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Next we ask about your experiences with diabetes self-management and using digital services.

Choose the option that best describes your situation

	Not at all satisfied	Not very satisfied	Not satisfied or	Pretty satisfied	Very satisfied
How satisfied are you with your diabetes self-management?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Does diabetes cause you challenged in your daily life? The challenges can be big or small. *

- Yes
- No

What challenges does diabetes cause you in your daily life?

Have you used digital services to support your diabetes self-management? *

- Yes
- No

Why have you not used digital services to support your diabetes self-management?

- I don't own a computer or don't have internet connection
- I don't know what digital services exist or I don't know how to find them
- Using digital services is difficult for me
- I'm worried about the safety of the digital services
- I don't feel the need to use digital services to support my diabetes self-management
- I'm not interested in digital services
- Something else, what? _____

Tell more about why you have not used digital services in your diabetes self-management?

In what situations have digital services helped you with your diabetes care?**How?**

Have you had a positive, pleasant experience regarding digital diabetes services? *

- Yes
- No

Have you had a negative, bad experience regarding digital diabetes services? *

- Yes
- No

What matters related to caring for diabetes would you want to take care of from your home?

Background information

What is your age?

- under 65
- 65 - 70
- 71 - 75
- 76 - 80
- 81 - 85
- 86 - 90
- 91 - 95
- over 95

What is your gender?

- Female
- Male
- Other / I don't wish to disclose it

What is your highest level of education?

- Primary school
- Elementary school
- Vocational school
- High School
- University degree
- Other, what?

Choose the option that best describes your situation

- I have type 2 diabetes
- My loved one has type 2 diabetes
- I have an another type of diabetes, what? _____
- Other, what? _____

How long have you had a diabetes diagnosis?

- Under a year
- 1 - 2 years
- 3 - 10 years
- 11 - 20 years
- Over 20 years
- I don't have a diabetes diagnosis

Thank you for your answer!

If you want, you can comment the questionanire or tell something we did not realize to ask:

Appendix B: Interview questions

For the purposes of this thesis, this is an English translation of the original Finnish questions.

Background information

1. What is your age?
2. What is your highest level of education?
3. How long has it been since receiving your diagnosis?
4. What is your treatment method?

The questions

1. How do you treat your diabetes daily?
2. How else does diabetes affect your life?
3. What challenges have you experienced due to diabetes?
4. Has diabetes brought any positive things to your life?
5. Is there an aspect of diabetes management you would especially hope to receive more support with?
6. Has diabetes ever caused any problem situations?
7. What services do you use in your diabetes self-management, both digital and others?
8. What do you think of them?
9. How have you found the digital services?
10. What device do you use to access them?
11. Where do you use them?
12. What kind of professional help do you receive with your diabetes treatment?
13. Does taking care of diabetes matters online differ somehow from doing it live?
14. Has forgetting things ever affected your diabetes self-management?
15. Do you have other health-related issues that affect your diabetes self-management?
16. If you could hope for any diabetes service, digital or other, what would it be?
17. Do you have anything you would want to tell the people who develop digital diabetes services?