Prospective acceptability of an mHealth intervention for self-managing gestational diabetes

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Tiivistelmä – Referat – Abstract

Gestational diabetes mellitus (GDM) is a condition of glucose intolerance with onset or first recognition during pregnancy, and it poses multiple health risks for both the mother and the child. The prevalence of GDM is increasing globally and effective interventions are needed to reduce the associated risks. Mobile health (mHealth) solutions have a great potential in answering this need since they are cost-effective and able to reach large groups of people. mHealth solutions might be especially effective for management of chronic conditions that require patient behavior change.

Investigating intervention acceptability has an important part in the process of developing successful interventions. The aim of this thesis is to investigate the prospective acceptability of an mHealth intervention for GDM from the perspective of its potential recipients. The thesis also seeks to find out whether there are any associations between technological experience and perceptions of intervention acceptability as well as ways in which the intervention acceptability could be improved.

The thesis utilizes data collected in the first phase of the eMOM GDM study, a research project with the aim of developing an mHealth intervention to support the self-management of GDM. The application acceptability was studied with semi-structured interviews with 10 women currently diagnosed with GDM. Previous technological experience was self-reported by the participants in a background questionnaire. Theory-driven content analysis was used to analyze the interviews.

The results show that the intervention has high prospective acceptability from the perspective of the potential participants. For most of the domains of acceptability there is still room for improvement, and several ideas for further improving the intervention's acceptability are discussed. The results could also indicate a possible relationship between technological experience and mHealth intervention acceptability.

This thesis contributes to the development of an intervention by providing insight on the factors influencing intervention acceptability and ideas on how to improve it. The results also provide valuable information for developing future mHealth solutions for GDM. The potential association between technological experience and intervention acceptability are interesting regarding all mHealth intervention development and should be studied further.

Avainsanat – Nyckelord – Keywords
mHealth, eHealth, acceptability, fidelity, intervention, gestational diabetes

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Tiivistelmä – Referat – Abstract

Raskausdiabetes on raskauden aikana alkava tai todettu glukoosi-intoleranssista johtuva sairaustila, joka aiheuttaa merkittäviä terveysriskejä sekä äidille että lapselle. Raskausajan diabeteksen ilmaantuvuus on maailmanlaajuisesti kasvussa ja tehokkaita interventioita tarvitaan siihen liittyvien terveysriskien pienentämiseksi. Mobiiliteknologiaa hyödyntävillä ratkaisuilla (mHealth) on potentiaalia tähän tarpeeseen vastaamisessa, sillä ne ovat kustannustehokkaita ja niillä voidaan tavoittaa potilasväestöä laajasti. mHealth-ratkaisut saattavat olla erityisen tehokkaita sellaisten kroonisten sairaustilojen hoidossa, jotka vaativat potilaan käyttäytymisen muutosta.

Intervention hyväksyttävyyden tutkiminen on tärkeä askel onnistuneiden interventioiden kehittämisessä. Tämän maisterintutkielman tavoite on tutkia raskausdiabeteksen omahoitoa tukevan mHealth-intervention prospektiivista hyväksyttävyyttä sen potentiaalisten osallistujien näkökulmasta. Tutkielma pyrkii myös selvittämään, ovatko aiempi teknologinen kokemus ja kokemukset intervention hyväksyttävyydestä yhteydessä toisiinsa. Lisäksi pyritään selvittämään, miten intervention hyväksyttävyyttä voisi parantaa.

Tutkielmassa käytetään aineistoa, joka on kerätty eMOM GDM -tutkimuksen ensimmäisessä vaiheessa. eMOM GDM on tutkimusprojekti, jonka tavoitteena on kehittää mobiilisovelluksen muodossa toteutettava interventio raskausajan diabeteksen omahoidon tueksi. Sovelluksen hyväksyttävyyttä tutkittiin puolistrukturoiduilla haastatteluilla. Haastatteluihin osallistui 10 raskausdiabetesdiagnoosin saanutta naista. Tieto teknologisesta kokemuksesta saatiin taustatietolomakkeesta, jonka osallistujat täyttivät osana tutkimusta. Haastatteluiden analysoinnissa käytettiin teoriaohjaavaa sisällönanalyysiä.

Tulokset osoittavat, että intervention prospektiivinen hyväksyttävyys potentiaalisten osallistujien näkökulmasta on korkea. Hyväksyttävyyttä voidaan silti edelleen parantaa sen lähes kaikilla osa-alueilla ja tutkielmassa esitellään useita tapoja tämän toteuttamiseksi. Tulosten perusteella on mahdollista, että teknologinen kokemus ja mHealth-pohjaisten interventioiden hyväksyttävyys ovat yhteydessä toisiinsa.

Tutkielma tukee intervention kehitystä tarjoamalla näkemystä tekijöistä, jotka vaikuttavat intervention hyväksyttävyyteen, sekä ideoita, miten hyväksyttävyyttä voidaan edelleen parantaa. Tuloksia voidaan hyödyntää myös tulevaisuudessa uusien raskausdiabeteksen hoitoon tähtäävien mHealth-interventioiden kehityksessä. Lisäksi mahdollinen yhteys aiemman teknologisen kokemuksen ja interventioiden hyväksyttävyyden välillä on kiinnostava muidenkin mHealth-interventioiden kehityksen kannalta ja sitä tulisi tutkia enemmän.

Avainsanat – Nyckelord – Keywords
mHealth, eHealth, hyväksyttävyys, fideliteetti, interventio, raskausdiabetes

1. Introduction

Gestational diabetes mellitus (GDM) is a condition of glucose intolerance with onset or first recognition during pregnancy (Metzger, Coustan & Organizing Committee, 1998). Gestational diabetes poses several health risks for both the mother and the child, including the mother's increased risk of developing type 2 diabetes (Bellamy, Casas, Hingorani & Williams, 2009) and metabolic syndrome (Puhkala et al., 2012), as well as the child's increased risk of obesity, glucose intolerance and type 2 diabetes in later life (American Diabetes Association, 2004; Gestational diabetes: Current Care Guidelines, 2013). The prevalence of GDM as well as prevalence of type 2 diabetes have increased significantly during the last decades, possibly as a consequence of increasing obesity (Ferrara, 2007). According to the Finnish national Current Care Guidelines for gestational diabetes, the elevated risk of developing type 2 diabetes can be reduced by weight loss to a normal weight as well as lifestyle changes of eating a healthy diet and exercising (Gestational diabetes: Current Care Guidelines, 2013). In the light of these guidelines, developing effective interventions targeting diet and exercise plays an important part in treating GDM patients and reducing the associated health risks. Control theory (Carver & Scheier, 1982) and self-determination theory (Deci & Ryan, 2000) seem to be promising theoretical frameworks for these kinds of interventions (Michie, Abraham, Whittington, McAteer & Gupta, 2009; Silva et al., 2011; Teixeira, Carraça, Markland, Silva & Ryan, 2012).

The World Health Organization defines electronic health (eHealth) as "*use of information and communication technologies (ICT) for health*" (WHO, 2020). This covers a broad range of digital technologies, including solutions such as internet platforms for patients and clinicians, electronic health records, and mobile applications for different purposes. Mobile health, *mHealth* for short, can be seen as a sub-branch of eHealth. Mobile health interventions utilize mobile phones and are most commonly delivered through SMS or mobile applications. Using applications enables complex interventions with multiple functions, which is probably why they nowadays are more popular than interventions based on SMS (Chen, Chai, Dong, Niu & Zhang, 2018). Mobile health solutions have many pros: they are cost-effective, easy to distribute and

able to reach large groups of people. Furthermore, the interventions can be delivered pretty much wherever and whenever, as the participant just needs a mobile phone to participate. According to some estimates, the amount of mobile phone owners will reach 90% and the amount of smart phone owners 70% of the global population by 2020 (Ericsson, 2015). This is one of the reasons why utilizing them in healthcare holds many possibilities (Carroll et al., 2017).

Interventions delivered through mobile applications could be especially useful in treatment of chronic diseases such as GDM where the treatment entails patient behavior change (McCurdie et al., 2012). These conditions often demand high levels of self-management from the patients, for example in the form of self-monitoring of blood glucose and diet. Motivating mobile applications could potentially be useful in supporting patients in this (Chen et al., 2018). Still, it is important to keep in mind that when it comes to chronic conditions, GDM is a special case, since it lasts only for a limited time, that is until the end of pregnancy. We do not yet have a clear conception of what kind of implications this might have for the intervention design. More research is needed in order to establish clear guidelines for designing mHealth for GDM.

Following the principles of user centered design improves the intervention's likelihood of being effective (McCurdie et al., 2012). This includes involving potential recipients of the intervention already in an early phase. In addition to studying the mHealth application usability with the recipients, developing a successful intervention requires considering intervention fidelity and acceptability (Bellg et al., 2004; Rixon et al., 2016; Sekhon, Cartwright and Francis, 2017). This gives the intervention designers a broader idea of what do the recipients think and how do they feel about the intervention and helps them identify its strengths and potential problems.

The eMOM GDM study (eHealth in treatment of gestational diabetes) is a joint project between Helsinki University Hospital (HUS), University of Helsinki and Aalto University, that aims to utilize mHealth in treatment of gestational diabetes. The goal is to develop and evaluate a system supporting clinical decision making and patient behavior change combining monitoring of diet, physical activity, sleep, stress/recovery and glucose monitoring within a single system (the eMOM GDM application). The study consists of three phases: a usability study (Phase 1), a feasibility study (Phase 2a),

an intervention study (Phase 2b), and an AI validation study in which machine learning and intelligent personalization will be applied (Phase 3). The eMOM GDM study is funded by its partners Business Finland, HUS, University of Helsinki, Aalto University, Fujitsu and Elisa. The current study is a part of the usability study (Phase 1) of the eMOM GDM study. It is a qualitative interview study that utilizes theory-driven content analysis. The aim of this study is to examine the prospective acceptability of an mHealth intervention for self-managing gestational diabetes from the perspective of its potential recipients.

2. Interventions and gestational diabetes

I begin this chapter by briefly introducing what is generally meant by health behavior change interventions as well as some central terms that are associated with the concept. Next I will present interventions designed specifically for gestational diabetes, and then move on to discussing how mHealth could be utilized in developing effective interventions for gestational diabetes.

2.1 Health behavior change interventions

Health behavior change interventions are interventions that utilize multiple different strategies to change the behavior of the targeted population to address a specific health related problem (Gitlin & Czaja, 2016, pp. 3–4). Good interventions are based on theory (Webb, Joseph, Yardley & Michie, 2010), and health behavior change interventions utilize different *behavior change techniques* (BCTs) based on different health behavior theories. Michie and colleagues have developed taxonomies of BCTs, the most recent one including a total of 93 BCTs (Michie et al., 2013). Taxonomies seek to answer to the problem of not knowing the "active ingredients" of the intervention, that is, which specific components in the intervention caused the change in participant behavior. They are also tools that enable accumulating evidence from different studies and thus developing increasingly effective interventions (Michie, 2008).

Interventions can be simple or complex. Complex interventions are usually described as having several interacting components (Craig et al., 2008), but the distinction is not

clear cut and multiple different definitions exist. For example, according to Petticrew (2011), most interventions are in fact complex, and sometimes it is just more pragmatic to treat them as simple interventions to understand the interventions and related questions better.

2.2 Interventions for gestational diabetes

Pregnancy is a special time from the perspective of behavioral interventions: pregnancy can be seen as a powerful 'teachable moment' for health-related behavior change. This means that during this period women may feel more strongly motivated to adopt beneficial health behaviors, which makes pregnancy an ideal time for interventions (Phelan, 2010). Furthermore, in a study made by Evans and O'Brien (2005) it was noted that being diagnosed with gestational diabetes can act as a strong motivator for making behavioral changes, so targeting interventions for pregnant women with a GDM diagnosis is well justified. According to the Finnish national Current Care Guidelines for gestational diabetes, the recommended ways of reducing health risk associated with GDM, such as the elevated risk of developing type 2 diabetes, are weight loss to a normal weight and lifestyle changes of eating a healthy diet and exercising (Gestational diabetes: Current Care Guidelines, 2013). These can be targeted with carefully designed lifestyle interventions. Lifestyle interventions dealing with gestational diabetes can be divided into two groups: some interventions aim to prevent GDM, often targeting women at risk for the disease. Others target already diagnosed women, aiming to minimize further adverse health effects associated with the disease, for example by reducing the elevated risk of developing type two diabetes. There seems to be potential in these interventions, although evidence of the effectiveness of both types of interventions has so far been limited (Bain et al., 2015; Gilinsky, Kirk, Hughes & Lindsay, 2015; Pedersen, Maindal & Juul, 2017). Reasons for this are for example small sample sizes of trials (Pedersen et al., 2017) and the small amount of methodologically robust trials (Gilisnky et al., 2015).

One example of the first mentioned group of interventions is a Finnish gestational diabetes prevention study called RADIEL which examined the effect of a lifestyle intervention in high-risk women on the incidence of GDM (Koivusalo et al., 2016; Rönö et al., 2014). An example that falls into the second group of interventions is a

study made in Tianjin to assess a lifestyle intervention's impact on type 2 diabetes risk in women previously diagnosed with GDM (Hu et al., 2012). The contents of these interventions were pretty similar, both of them targeting physical activity and diet and utilizing BCTs such as *goal setting* (both *outcome*, such as body weight targets, and *behavior*, such as target amounts for physical activity), *self-monitoring of behavior* (filling diet logbooks. In RADIEL also using a pedometer for measuring steps), *action planning* (planning individual diet and exercise programs), and *instruction on how to perform a behavior* (counseling on an appropriate diet) (Hu et al., 2012; Koivusalo et al., 2016; Rönö et al., 2014). The Tianjin intervention also used *graded task* with physical activity, gradually increasing the amount of activity required to reach the goals (Hu et al., 2012). In RADIEL, the intervention was delivered by specifically trained study nurses and nutritionists. The participants had counseling appointments every three months before and during pregnancy. The intervention also included three visits postpartum. (Rönö et al., 2014.) The Tianjin intervention was delivered by a trained dietitian. The first weeks of the intervention were most intensive, after which the intervention reached a "maintenance phase" (weeks 12-24) during which the number of visits decreased to two sessions per year. (Hu et al., 2012.) Number of visits during the first part of the Tianjin intervention was not reported.

The RADIEL intervention was successful in increasing the intervention group participants' physical activity and improving their diet during pregnancy. In the control group no similar changes were detected. The intervention reduced the incidence of GDM in high-risk pregnant women by 39%. (Koivusalo et al., 2016.) In the Tianjin study, women in the intervention group had decreased BMI, body fat, waist circumference, and plasma insulin levels compared with the control group. In addition, they had increased leisure time activity and dietary fiber intake and decreased sedentary time and fat consumptions. Based on its success in impacting these risk factors, we can assume that the intervention has potential for preventing type 2 diabetes in women previously diagnosed with GDM. (Hu et al., 2012.)

Michie and colleagues (2009) systematically reviewed 122 interventions aiming to increase physical activity and healthy eating in the general adult population (18 years or over). In this study they found that interventions combining self-monitoring with at least one other BCT based on control theory (Carver & Scheier, 1982) were

significantly more effective in promoting physical activity and healthy eating than the other interventions. (Michie et al., 2009.) Control theory focuses on human self-regulation (Carver & Scheier, 1982), and BCTs based on control theory include for example *providing feedback*, *prompting self-monitoring*, and *goal setting*. All of these were also utilized in the successful RADIEL and Tianjin interventions (Abraham & Michie, 2008; Hu et al., 2012; Koivusalo et al., 2016; Rönö et al., 2014). Based on these findings control theory seems as a promising theoretical base for interventions aiming to increase PA and improve diet, but it should be noted that the review by Michie and colleagues (2009) only included studies conducted in healthy populations, not those at risk or with chronic disease. Because of this reason the findings might not necessarily be relevant for women with gestational diabetes. An alternative theoretical framework for GDM interventions could be self-determination theory (Deci & Ryan, 2000).

Self-determination theory (SDT) explains human motivation. It is based on years of empirical research and sees humans as naturally growth-oriented (Deci & Ryan, 2000). According to the theory, this natural orientation can be supported by satisfying three basic psychological needs of autonomy, competence and relatedness. Furthermore, SDT proposes that there are important differences in motivation quality, not just quantity: the different regulatory styles vary from purely intrinsic motivation to external regulations and amotivation, but there is also plenty in between. The distinction SDT focuses on is between *autonomous* and *controlled* motivation. The characteristics of autonomously motivated behavior are that the action is performed because it is experienced as personally important and compatible with the individual's values. When an action is motivated by the hope for a reward or is performed to avoid a punishment, the regulatory style is controlled. It is good to keep in mind that these rewards or punishments do not have to be material. Autonomous motivation tends to lead to better performance in the long run than controlled motivation. According to the theory, external regulations can also be gradually internalized. (Deci & Ryan, 2000.)

SDT has been used as a foundation for several interventions targeting different health behaviors, such as exercise and eating a healthy diet. The basic idea of these kind of interventions is to support autonomous motivation and the basic psychological needs in order to induce long-term behavior change. In a systematic review on relations between SDT based constructs and physical activity Teixeira and colleagues (2012) found that of

the seven interventions reviewed, six found significant differences between the intervention group and the control group in perceived autonomy support, need satisfaction, autonomous and introjected regulations for exercise, as well as higher levels of self-reported exercise. In a study with diabetes patients, perceived autonomy support from health care providers led to improvements in glucose control (Williams, Freedman & Deci, 1998).

To describe an SDT based intervention in more detail, a behavior change intervention based on SDT proved also successful in long term weight loss and increasing physical activity (Silva et al., 2011). The participants were women aged 25-50 years with a body mass index between 25 and 40. The intervention lasted for one year and focused especially on the participants' autonomy support. The intervention included 30 sessions targeted at increasing PA, adopting a diet with a moderate energy deficit, exercise and eating habits that support weight maintenance. The participants' autonomy was supported for example by encouraging them to autonomous decision making and defining their own personal goals for the treatment. A two-year follow-up period was also included in the study. At the interventions end, weight loss and levels of moderate and vigorous exercise were higher in the intervention group than in the control group. Perceived need support and autonomous regulation were also higher in the intervention group. The differences in weight loss and amount of exercise between the intervention group and the control group remained even after the 2-year follow-up period. (Silva et al., 2011.)

Based on the presented two intervention studies for GDM, it would seem that lifestyle interventions targeting physical activity and diet are effective for both reducing the incidence of GDM in high-risk women and reducing the risks associated with the disease, such as type 2 diabetes, in already diagnosed women. Furthermore, it seems that self-determination theory provides a promising theoretical base for these kinds of interventions. According to the meta-analysis conducted by Michie and colleagues (2009), interventions utilizing self-monitoring and control theory based BCTs seem to be most effective in inducing positive change in these target behaviors, but it is not clear whether these findings are relevant for women diagnosed with GDM, since the review only included studies conducted in healthy populations.

One of the downsides of behavioral interventions like the ones described in this chapter is that they can be quite costly, majority of the costs consisting of staff time needed in order to deliver the intervention (Diabetes Prevention Program Research Group, 2003). One interesting solution to consider is the potential of mHealth interventions for gestational diabetes.

2.3 Potential of mHealth interventions for gestational diabetes

Mobile health solutions have many pros compared to "traditional" behavioral interventions like the ones described in the previous chapter: they are cost-effective, easy to distribute and able to reach large groups of people. It seems that mHealth interventions can be especially effective for conditions where treatment is dependent on patient behavior change (McCurdie et al., 2012). Furthermore, women of reproductive age usually are adept in using digital technologies (Mackillop et al., 2018), so mHealth interventions could be a good way of supporting the treatment of GDM patients.

There is already a wide variety of existing diabetes applications and pregnancy applications. In fact, in 2018, there were more than 2000 diabetes smartphone applications available for Android and iOS (Huang, Soljak, Boehm & Car, 2018), but applications aimed specifically for gestational diabetes are nearly non-existent. For this reason, I focus first on applications designed for diabetes generally, and then discuss the specific needs and challenges that pregnancy and GDM bring to the design.

Typical functions for diabetes applications include for example physical activity tracking, food logging, blood glucose level monitoring and weight management. Systematic reviews of diabetes applications have shown that they can be useful tools in managing diabetes, and even other chronic conditions. They can, for example, contribute to health education of patients by providing useful information and strengthen their confidence in managing their diabetes. (Bonoto et al., 2017.) In addition, results of a review show that mobile applications for type 2 diabetes are effective in improving glycemic control of diabetes patients (Hou, Carter, Hewitt, Francisa & Mayor, 2016). Chen and others (2018) note that in addition to these benefits,

mHealth has the potential to encourage patients' self-management of their condition, which holds a central role especially in treatment of chronic conditions such as diabetes.

The literature shows that mHealth solutions have the potential to be useful and effective in diabetes management, but this may not always be the case. For example, in their review on mHealth interventions for long-term illnesses De Jongh, Gurol-Urganci, Vodopivec-Jamsek, Car and Atun (2012) note that we still do not have enough information about long-term effects and acceptability of these interventions. Regarding pregnancy applications, a systematic review on mHealth interventions for maternal and child health found that 43% of the randomized controlled trials reviewed showed negative or unclear results (Chen et al., 2018). So why is it that while mHealth interventions have all the potential to be effective, they quite often are not? According to Huang and others (2018), some of the problems with mHealth applications for diabetes are that they often are not user friendly, users do not trust the information that they provide, and they are not perceived to be useful by the users. A possible cause for these problems is the fact that patients and clinicians are not often involved in the development process of the intervention (Huang et al., 2018), even though co-designed mHealth interventions might be more effective than those mainly designed by researchers and clinicians (Eyles et al., 2016). Stawarz, Cox and Blandford (2015) state that most applications designed for supporting behavior change aren't based on relevant theory, although it is known that theory-based interventions tend to be more effective (Webb et al., 2010).

It also needs to be taken in account that women with gestational diabetes form a rather specific target group, since they not only need to manage their diabetes, but possibly need support for their pregnancy too. This is the reason why it is not enough for mHealth application developers to draw their information and ideas from diabetes applications when designing mHealth solutions for gestational diabetes. Pregnancy mHealth is another large field, and looking at this literature we can state that pregnancy brings its specific requirements and restrictions into application development including, but not limited to, additional challenges for self-monitoring (Peyton, Poole, Reddy, Kraschnewski & Chuang, 2014) and expectations for personalized application content (Goetz et al., 2017). Furthermore, as mentioned before, GDM brings its own specific challenges for the design as it at the same time is, and is not, a chronic condition. It only

lasts until the end of the pregnancy, but the health risks for both the mother and the child extend further. As there currently is very little research done in the specific area of mHealth for GDM, there are no established design guidelines to follow.

Keeping these potential pitfalls in mind, there are a few things researchers can do to develop successful and user friendly mobile health interventions: utilizing relevant theories (Webb et al., 2010), involving users in the design (Abras, Maloney-Krich & Preece, 2004; McCurdie et al., 2012) and investigating fidelity and acceptability of these interventions already in an early phase of the development (Bellg et al., 2004; Rixon et al., 2016). Users are needed especially in the development of mHealth interventions, since as said before, established design guidelines for GDM mHealth do not yet exist.

3. Theoretical background

In this section I will present the theoretical background for the current study. I will start by introducing the more general concept of intervention fidelity, and then move on to intervention acceptability. Lastly, I will describe why there might be associations between technological experience and intervention acceptability.

3.1 Intervention fidelity

According to Horner, Rew and Torres (2006), intervention fidelity means, simply put, that the intervention was conducted as planned. Ensuring intervention fidelity is important in order for the researchers to accurately interpret associations between intervention and outcomes (Bellg et al., 2004; Horner et al., 2006). Disregarding fidelity may lead to discarding potentially effective interventions, if the ineffectiveness of an intervention is explained by intervention components or design rather than acknowledging that there might be problems with implementation (Bellg et al., 2004; Rixon et al., 2016).

The Treatment Fidelity Workgroup part of the National Institute of Health (NIH) Behavior Change Consortium (BCC) defined intervention fidelity as ”*the*

methodological strategies used to monitor and enhance the reliability and validity of behavioral interventions" (Bellg et al., 2004, p. 443). They also proposed a framework of fidelity with five components: *design*, *training*, *delivery*, *receipt* and *enactment*: the study should be *designed* so that it can adequately test its hypotheses. This involves factors such as controlling the intervention dose/intensity across different conditions and developing procedures to deal with possible setbacks in implementation. *Training* of the intervention providers should be conducted in a way which ensures that they are able to deliver the intervention as it was intended. Training should be standardized so that all providers are trained in a similar way. Furthermore, it is important that the intervention is *delivered* as it was intended, which should be ensured by controlling intervention content, intensity and differences between providers. Dumas, Lynch, Laughlin, Smith & Prinz (2001) note that even process fidelity in the delivery is important, referring to that the protocol must be administered in the same way with all participants. Intervention *receipt* includes ensuring that the participant understands the intervention and is able to use the behavioral and cognitive skills taught in the intervention, while *enactment* refers to ensuring that the participant actually uses these skills. The first three of these components relate to providers of interventions, while in the latter two the focus shifts to the intervention participants (Bellg et al., 2004).

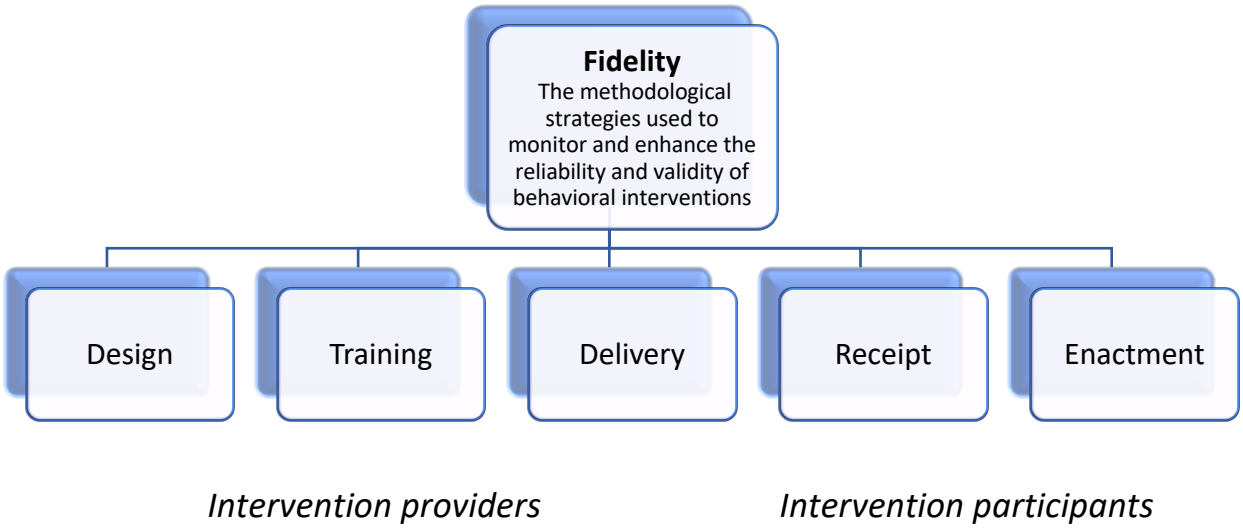

Figure 1. Framework of intervention fidelity. Based on Bellg et al., 2004

Today it is common to consider patients active participants in their own treatment rather than passive recipient, and especially in case of chronic conditions (such as GDM) the

central role of patient self-management is well acknowledged (Mulligan, Steed & Newman, 2009). This active role demands that intervention participants actually understand and engage with the intervention, so that they are able to acquire intervention related skills and apply them in their lives (Rixon et al., 2016). In order to ensure this, we need to take a closer look at the participants' perceptions of the intervention already in the design phase. An important part of this is studying intervention acceptability. In previous literature acceptability is often seen as a closely related but distinct construct from fidelity (see for example Gould et al., 2014), and such is the case in this study as well.

3.2 Intervention acceptability

According to Craig and others (2008), in order to develop a successful healthcare intervention, it is important to conduct a pilot study to assess the intervention acceptability. Overdjink and colleagues (2018) note that this is true especially for mobile applications related to maternal health, since unnecessary information and advice can lead to increased stress for pregnant users.

Acceptability can be studied both from the perspective of intervention providers (e.g. healthcare professionals) or from the perspective of intervention recipients. In this study the focus is on the latter, which is why the perspective of the intervention providers is not examined at this time.

Acceptability is a necessary prerequisite for the success of an intervention. Acceptability may critically affect the intervention's effectiveness (Diepeveen, Ling, Suhrcke, Roland & Marteau, 2013; Sekhon et al., 2017), and thus holds an important role in determining why some interventions work while others do not. It is often defined as something related to how the user thinks or feels about the intervention, and many studies have been done to evaluate acceptability of interventions and mHealth applications. Most of the acceptability research so far, however, suffers from the fact that definitions for *acceptability* are varying and often vague, and in several cases even lacking from the articles altogether. Furthermore, measures of acceptability are rarely based on any kind of theory. For example, in their overview of systematic reviews investigating acceptability along with other factors, Sekhon and colleagues (2017)

found no mention of theory in relation to acceptability in any of the 43 reviews included. Consensus on how acceptability should be assessed is also lacking. (Sekhon et al., 2017.) To illustrate these problems within acceptability research, I will briefly present some examples of studies claiming to evaluate acceptability:

1) Kardas and Lewandowski (2015) claim to in their study have evaluated acceptability from the patients' perspective, a generic questionnaire assessing *health-related quality of life* as their measure of said acceptability.
2) Burkow, Vognild, Johnsen, Bratvold and Risberg (2018) have assessed patients' acceptance by semi-structured interviews, the definition of acceptance being "*the extent to which services were generally approved and used, patients' satisfaction with services and the perceived usefulness of services*".
3) Herring and colleagues (2016) describe using an "acceptability questionnaire", but do not elaborate on what kind of measures the questionnaire includes.

If we look at these three examples, it is quite clear that studies 1 and 2 have not been studying the same construct. For the third example it is difficult to say anything, since we do not really know what they mean by acceptability. These examples describe the core problem within acceptability research well: researchers are interested in it, but do not really share a consensus on what it is and how it should be measured.

As a response to these issues, Sekhon and colleagues (2017) have developed a theoretical framework grounded on an overview of systematic reviews on acceptability of healthcare interventions. They examined conceptual and operational definitions for acceptability found in the different studies and based on a combination of these and relevant theories and frameworks in health psychology aimed to discover a comprehensive definition of acceptability and its core empirical indicators. The definition of acceptability they settled upon is "*a multi-faceted construct that reflects the extent to which people delivering or receiving a healthcare intervention consider it to be appropriate, based on anticipated or experiential cognitive and emotional responses to the intervention*" (Sekhon et al., 2017, p. 4). The different domains of acceptability in this model include affective attitude, burden, ethicality, intervention coherence, opportunity costs, perceived effectiveness and self-efficacy.

Affective attitude is defined as how an individual feels about participating in the intervention. This construct was a combination of different attitude measures found in the overview of reviews. *Burden* refers to how much effort (for example time or cognitive effort) is perceived to be required in order to participate in the intervention. In the overviewed reviews this domain was reported as reasons for discontinuation or dropout. The definition was Oxford dictionary defines burden as a ”heavy load”, which inspired the definition for this area of acceptability. The construct of *ethicality* tells us how compatible the intervention is with the individual's values. The original label in the TFA was “ethical consequences”, but it was later changed. In the overview this construct was reported as associated side effects with intervention.

Intervention coherence describes how well the individual understands the intervention and how it is supposed to work. This construct was added to the model as a consequence of deductive theorizing based on the authors’ knowledge on existing health-psychology theory, and represents the face validity of the intervention from the perspective of the recipient or deliverer.

Opportunity costs is defined as the amount of benefits, profits or values the individual feels must be given up in order to engage in the intervention. In the reviews this domain was reported as influence on adherence and participation, and the definition itself was inspired by health economics literature. *Perceived effectiveness* answers to the question of if the individual thinks that the intervention is likely to achieve its goal. According to the authors, this perceived effectiveness is likely to influence the perceptions of acceptability.

The last domain, *self-efficacy*, was added to the model based on existing health psychology literature. The construct reflects the patient’s personal control and confidence, and answers to the question if the individual feels that they are able to do everything that is required in order to participate in the intervention. The construct was originally split in two, “treatment control” and “personal control”, but these were later combined under the commonly used label of self-efficacy.

The first version of the model included even *intention*, but it was later removed. In the final version of the TFA the different domains of acceptability are rather seen as

predictors of intention. This shift was inspired by the Theory of Planned Behavior (Ajzen, 1991), in which intention is described as an indication of how motivated people are to perform the behavior. Since intention is a powerful predictor of behavior, acceptability could be an important factor in defining the individual's willingness to participate in the intervention and perform the required behaviors.

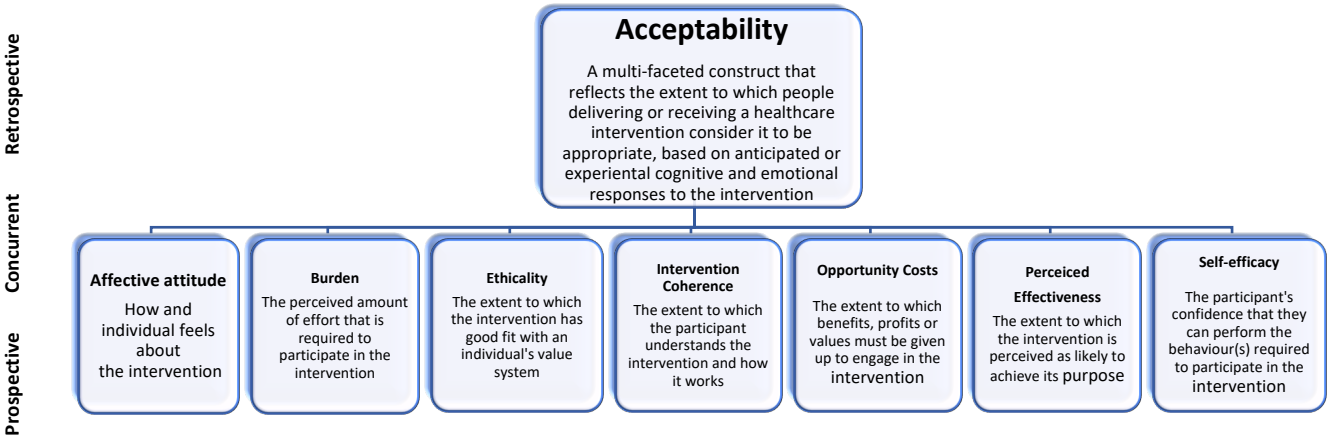

Figure 2. Theoretical framework of acceptability. Based on Sekhon, Cartwright & Francis, 2017

Lastly, an important feature of the TFA is the distinction between three temporal perspectives. These are prospective (forward-looking) acceptability, concurrent acceptability and retrospective (backward-looking) acceptability. Prospective acceptability can be studied *prior to* participating in the intervention, concurrent acceptability *while* participating in the intervention, and retrospective acceptability *after* having participated in the intervention. This study will be looking at the prospective acceptability, since the participants have not actually participated in the intervention and their perceptions of the intervention acceptability are based on their first impressions.

3.3 Technological experience and intervention acceptability

Venkatesh, Morris, Davis and Davis (2003) have developed a model called the Unified Theory of Acceptance and Use of Technology (UTAUT). The model answers to the need for a unified model for user acceptance of new information technologies in organizations and combines elements of several theories previously seen as competing with each other (Venkatesh et al., 2003). Acceptance for the use of technology differs

as a theoretical concept from the one of intervention acceptability. Still, it is definitely useful in the context of investigating an mHealth intervention, that essentially is not just an intervention, but also a technological solution. Furthermore, the UTAUT and TFA models are actually based on similar theories. For example the Theory of Planned Behavior (Ajzen, 1991) contributes to both models as both recognize the importance of intention: UTAUT identifies intention as a key factor leading to use behavior, while TFA sees the different domains of intervention acceptability as predictors of intention. (Sekhon et al., 2017; Venkatesh et al., 2003.)

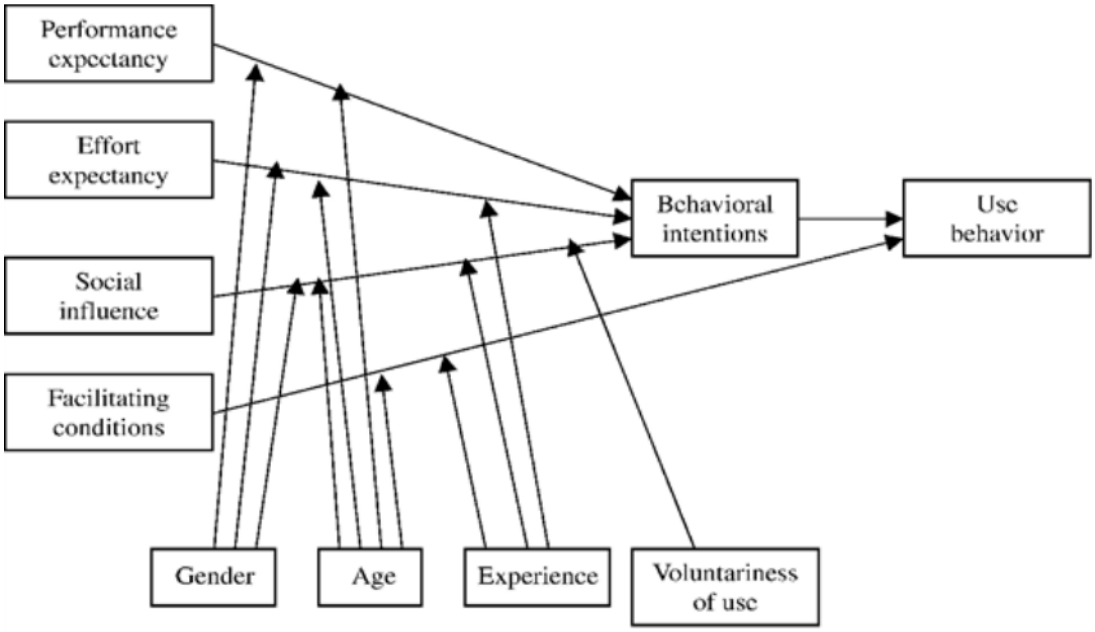

Figure 3. Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003).

According to the UTAUT model (Venkatesh et al., 2003), effort expectancy affects use behavior via behavioral intentions. The construct of effort expectancy refers to the ease of use of the technology, and moderating factors for its effect on behavioral intentions are gender, age and experience, the effect being strongest for older women with relatively little experience in using different technologies. Based on this model, there is reason to expect that experience in using technologies is associated with acceptance in the population of women diagnosed with GDM. This might be especially true regarding the acceptability domain of burden, since the TFA definition of burden is pretty similar with the UTAUT concept of effort expectancy. We can assume that self-estimated amount of effort the application use would cause is probably higher for less experienced

users.

Based on different social psychological theories, there is reason to believe that past experience is associated with the participants' sense of self-efficacy and their affective attitudes at least. According to the self-efficacy theory by Bandura (1977), personal performance accomplishments are an important source for self-efficacy. Positive efficacy expectations are built by repeated success, and when established, diminish the negative effect of eventual failure on self-efficacy. Positive efficacy expectations also tend to generalize on similar situations, which is why even the experience in using different mobile applications is relevant for the self-efficacy regarding the use of this particular application. The theory of planned behavior (Ajzen, 1991) also identifies perceived behavioral control, a concept inspired by Bandura's concept of self-efficacy (1977), as well as attitudes as important determinants of intention. As according to this theory perceived behavioral control and attitudes also affect each other, we could assume that previous experience is also associated with the acceptability domain of affective attitude.

4. The current study

The intervention that is being developed in the eMOM GDM study is a mobile application with the purpose of supporting self-management of GDM and thus reducing associated adverse health effects. As interventions targeting diet and physical activity seem to be effective for this purpose, this mHealth intervention aims to support GDM self-management by helping the patients monitor their blood glucose levels and induce behavior change in diet and physical activity if needed. Furthermore, the application helps monitor sleep and stress levels and support behavior change regarding these as well. This study uses an interactive prototype of the application. Pictures of the prototype could not be published because the final version of the application is not yet released.

The application utilizes self-tracking and different sensors such as an activity bracelet and a continuous glucose monitoring sensor. Information from all of these are integrated into a single application, enabling self-monitoring of blood glucose, physical activity,

sleep and stress. Diet is tracked by the participants with a speech enabled food diary, also integrated in the application.

The intervention uses self-determination theory (Deci & Ryan, 2000) as a theoretical base. This particular theory was chosen, because as described earlier, SDT based interventions are effective at least for the purposes of increasing physical activity (Teixeira et al., 2012) and improving glucose control for patients with diabetes (Williams, Freedman & Deci, 1998). SDT based mechanisms in the application aim to support behavior change aim to increase the participants' autonomous motivation by supporting their basic psychological needs for autonomy and competence. For example, the application enables creating personal and goals for the target behaviors, thus supporting user autonomy. Reaching the self-set goals then supports competence, as well as the encouraging feedback provided by the application. Features to support relatedness, such as engaging with other participants, are also being planned.

The application also uses several BCTs to support behavior change (Michie et al., 2013). In their systematic review of interventions aiming to increase physical activity and healthy eating, Michie and colleagues (2009) found that interventions combining self-monitoring with at least one other BCT based on control theory (Carver & Scheier, 1982) were significantly more effective compared to the other interventions. In addition to other BCTs, this application utilizes self-monitoring as well as other control theory based BCTs (*providing feedback*, *goal setting* and *action planning*):

- The different sensors support *self-monitoring of behavior* (2.3). The data provided by the sensors also provide *biofeedback of behavior* (2.6).
- The application provides *feedback of behavior* (2.2) in the form of graphs for daily, weekly and monthly physical activity and diet. The data comes from the sensors.
- The application has mechanisms for *goal setting (behavior)* (1.1), *action planning* (1.4) and *habit formation* (8.3). The application allows for the user to create, customize and track habits fit to support her personal priorities.

- The application provides reliable *information about health consequences* (5.1) and *comparative imagining of future outcomes* (9.3). These will be supported by machine learning models developed later in phase 3 of the eMOM GDM study.
- The application uses mechanisms such as push notifications as *prompts and cues* (7.1) to remind the users of relevant actions, such as using the sensors and performing the actions needed to reach the goals set.

In the eMOM GDM study potential recipients are included in the intervention development from the start according to the principles of user centered design in mHealth (McCurdie et al., 2012). This is done to ensure intervention effectiveness, fidelity and acceptability.

The current study is a part of the phase 1 of the eMOM GDM study. The research questions of this study are
a) How do the potential recipients perceive the acceptability of the intervention in the different acceptability domains of the TFA (*affective attitude, burden, ethicality, intervention coherence, opportunity costs, perceived effectiveness* and *self-efficacy*) from a prospective point of view?
b) Are there any associations between the participants' technological experience and their perceptions of the acceptability of the intervention?
c) How could the acceptability of the intervention be improved?

5. Data and methods

This is a qualitative study using semi-structured interviews as a data collection method. The epistemological background for doing interviews is that they allow us to tackle personal experiences and that they can be used as a means to access the meaning-making and reflection people do about meaningful issues, and furthermore, that these individual reflections on personal experiences can be used as a way of understanding these issues and the experiences of individuals in similar situations. Semi-structured interviews initially follow a planned structure but allow some flexibility. Therefore, the interviewer can for example diverge from the planned questions, if something interesting comes up. (Flick, 2007.) Sekhon and colleagues (2017) identify semi-

structured interviews as a suitable method for data collection in qualitative studies evaluating intervention acceptability.

This study was a part of phase 1 of the eMOM GDM study. In phase 1, usability and acceptability of sensors that are going to be integrated into the eMOM GDM application, as well as acceptability of the prototype of the eMOM GDM application, were studied. An ethical approval for phase 1 of the eMOM GDM study was obtained from The Ethics Committees of the Helsinki and Uusimaa Hospital District. Confidentiality and data security were ensured by keeping the interview data anonymous and only sending study related data through secure channels. Only researchers in the study were allowed to handle the data.

Participants

10 pregnant women diagnosed with gestational diabetes were recruited to the study from health center maternity clinics (*neuvolas*) in the cities of Helsinki and Espoo and from the hospital maternity clinic (*äitiyspoliklinikka*) in Helsinki by study nurses and maternity clinic nurses. This sampling was chosen because the participants should represent potential participants of the intervention. The clinic nurse asked potential participants for interest in participation, and if interested, the study nurse contacted the mother with more information of the study and confirmed eligibility. Exclusion criteria for the study were type 1 or type 2 diabetes, use of medication that influences glucose metabolism in the beginning of the study (e.g. oral corticosteroids, metformin, insulin), a GDM diagnosis in previous pregnancies, current substance abuse, severe psychiatric disorder, significant difficulty in cooperating (e.g. inadequate Finnish language skills) and significant physical disabilities that prevent the use of a smartphone or moving without aid. In addition, the participants had to be at least on their 24th week of pregnancy and have a smartphone with a operating system that is compatible with the tested application at their disposal.

Procedures

After confirming their participation with the study nurse, the participants had their first appointment with the study nurse and research assistant. In most cases the research assistant in question was me. For two of these appointments I was not available, in

which case another research assistant jumped in for me. In this initial meeting the participants first signed informed consent forms and were told that they were allowed to discontinue the study at any time.

The participants were handed the sensors described in Table 1 and were instructed how to use them. All the sensors except for the Firstbeat Bodyguard 2 could be used with a mobile application, so the participants also received an iPod Touch in which applications of the different sensors were previously downloaded. The application of one sensor, VivoSmart 3, was instead downloaded in the participant's own smartphone during the meeting, since we ran into some problems with its compatibility with the iPod. During the meeting the study nurse also attached the Medtronic glucose meter into the participant's upper arm and measured the height, weight and waist circumference of the participant.

The participants had a chance to address any possible concerns regarding their participation with the study nurse and the research assistant, as well as ask any questions they might have about the study. Furthermore, during this meeting the participants filled out a background questionnaire and a questionnaire about acceptance of the sensors (Venkatesh et al., 2003). Dates for phone appointments with a nutritionist (to check the diet logbook) and the research assistant (to give feedback from the Firstbeat-measurement) were scheduled. After the initial meeting the participants had a study period of six full days, during which they used four different sensors simultaneously. During this time the participants also filled out a logbook of their physical activity and sleep for six days, and of their diet for three days. Contact information of the study nurse and the research assistant were given to the participant in case they would encounter any problems during the study period.

Table 1. Sensors worn by the participants.

Sensor name	Type	Wearability
Garmin VivoSmart 3	Activity tracker	Worn on the wrist.
ExSed	Physical activity, sedentary behavior and sleep sensor	Attached either to a belt around the hip or to pants with a clip. Worn on the wrist during the night.
Medtronic	Continuous glucose meter with a sensor and a transmitter	Sensor attached under the skin on the upper arm.
Firstbeat Bodyguard 2	Heart rate variability (HRV) sensor	Attached to the chest with two disposable ECG electrodes (electrodes replaced at least once a day).

After the study period the participants met with the research assistant to fill out the questionnaire about acceptance of the sensors again and took part in semi-structured individual interviews. The participants were interviewed individually by one, or in some cases two, research assistants. I was the principal interviewer in seven of the ten interviews and had another research assistant helping me in the three first interviews. For the three last interviews I was unavailable, so they were handled by a third research assistant. The interview consisted of two parts, the first part focusing on the usability and acceptability of the sensors used during the study period, and the second part on the usability and acceptability of the application. In the second part, the participants did a walkthrough of the prototype of the eMOM GDM -application. The research assistant first briefly presented the idea of the application and the limitations of the prototype (it was possible to move between different screens, but the prototype was not truly interactive). Then she or he instructed the participant to freely browse the prototype and encouraged her to think aloud and voice any possible questions or comments that might come to mind while doing so. If the participant did not find all of the screens available in the prototype, the research assistant jumped in and showed her the screens she had missed. Afterwards the research assistant asked the participant questions regarding the

usability of the application, and finally questions regarding her perceptions of the intervention's acceptability.

The interviews took place in either University of Helsinki Kumpula campus, the Aalto University Otaniemi campus or the premises of HUS in Meilahti, depending on which of these locations was most convenient for the participant. The interviews lasted from one to two hours, and we allowed for breaks if the participant needed them. The interviews were audio recorded and transcribed verbatim for analysis. Oral permission for recording was obtained before the interview from each participant.

Data

In the current study, the following data gathered in the phase 1 of the eMOM GDM - study were used:

Semi-structured interviews.

The interviews resulted altogether in about 150 pages of transcripts. This study focuses on the part of the interview that covers prospective intervention acceptability, which was approximately 40 pages. The following questions assessing intervention acceptability were formulated to target each construct of the theoretical framework of acceptability by Sekhon and colleagues (2017). The interviews were conducted in Finnish, and the original interview questions have here been translated to English. The interview questions in their original language are listed in appendix 1 (p. 70).

- Affective attitude:
    - How do you feel about the application? How does it feel to use/browse it?
    - How would you feel about the idea of using the application in your daily life?
- Burden:
    - If you were to use the application in your daily life, what would it require from you?
        - What would you have to learn?
        - How much effort would it require from you?

- Ethicality:
    - What kind of values do you think the application represents?
    - How well do you think the application fits with your own value system?
- Intervention coherence:
    - What do you think is the meaning/goal of the application? How do you feel about it/what do you think about it?
- Opportunity costs:
    - What would you have to give up in order to use the application in your daily life?
- Perceived effectiveness:
    - How do you think the application could help you in…
        - Managing your blood sugar levels?
        - Supporting your stress management and recovery?
        - Increasing your physical activity/maintaining a good level of physical activity?
        - Sleeping enough?
- Self-efficacy:
    - How do you think you would manage using the application independently?

Background questionnaire.

Answers to the statement "I am accustomed to using different mobile applications" on a scale of 1 (completely disagree) to 5 (completely agree) were used in this study to map out the participants' technical skills relating to mobile application use. The answers are presented in chapter 6.1 in Table 2.

Analysis

The method used for analyzing the interviews is theory-driven content analysis with both deductive and inductive coding. Although the amount of the data was manageable even without any complex tools, the ATLAS.ti software was used in the analysis to help perceive the connections between different themes as well as the contexts in which the themes emerge in. This also helped to manage the data and quotations associated with different themes.

According to Tuomi and Sarajärvi (2009), in a theory-driven content analysis, categories are defined based on previous research or theory, and from the data content is sought to these pre-defined categories. Therefore, theory-driven content analysis is guided by an existing theory (Tuomi & Sarajärvi, 2009). In this study the theoretical framework of acceptability (TFA) by Sekhon and others (2017) was used as a starting point, which makes theory-driven content analysis a fitting method. The role of the researcher in qualitative analysis is to interpret what the participants say, which demands taking the perspective of the participants. Since the interpretations made can never be fully accurate or objective, the analysis will inherently be a construction of the world. (Gibbs, 2007.)

I started by looking for content describing each of the TFA's acceptability domains (Affective attitude, burden, ethicality, intervention coherence, opportunity costs, perceived effectiveness and self-efficacy) from the interviews. The domains thus functioned as the upper categories in the analysis. The next phase represented a more inductive approach, as I started analyzing the contents of these categories, coding the interviews by emerging themes representing the participants' thoughts and feelings on intervention acceptability (for example: *thinks that the application feels gentle* or *thinks that she would know how to use the application independently*). The unit for coding varied from phrase to paragraph, depending on length of the excerpt needed to convey the meaning behind each code. Individual words were in this case not used as codes. After initially coding all of the interviews, I combined overlapping or similar codes into larger categories (for example *thinks that the graph view is confusing + some screens feel unclear = some parts of the application feel confusing*). To conclude the analysis, I chose the most important and interesting themes regarding each domain. These were either themes mentioned by several participants, thoughts or feelings that stood out in the data, or topics with interesting implications for improving the intervention acceptability.

6. Results

In this section I will present the results of this study. I begin by introducing the answers regarding the participants' technological experience which were obtained from the background questionnaire. Then I move on to present the findings from the interviews one acceptability domain at a time while paying attention to the possible differences in participant technological experience. The decision to order the results in this way was made to enable considering the participants' technological experience and perceptions of acceptability simultaneously.

The interviews were conducted in Finnish and I have translated the quotes used in this chapter to English. The original quotes can be found in appendix 2 (pp. 71—79). The participants are identified by number sequences assigned to them in the beginning of the study period.

6.1 Technological experience

The results show that in general the participants were very familiar with using different mobile applications. In fact, only one participant disagreed with the statement, her answer being 2. All the other participants ranked their level of experience with mobile applications significantly higher, their answers varying between 4 and 5. Data from the background questionnaire is presented below in table 2.

Table 2. Data from the background questionnaire.

Participant's study id	Accustomed to using different mobile applications (1-5)
11-101	4
11-102	4
11-103	4
11-104	5
11-105	4
11-106	5
11-107	2
11-108	5
11-109	5
11-110	5

In the analysis of the interviews I am interested in whether this technological experience related to application use is associated with the participants' perceptions of intervention acceptability.

6.2 Perceptions of acceptability

Affective attitude

The first domain, affective attitude, refers to the individual's feelings towards the intervention (Sekhon et al., 2017). In order to address affective attitude, we asked the participants how they felt about the application and browsing the prototype. We also asked how they would feel about the idea of using the application in their daily life.

In the interviews, several participants expressed that they would gladly use this kind of application, and some even felt sorry that they did not have the chance to do so during their pregnancy.

> *But it is like, then again, it has so many interesting things. So because of that I'd probably be quite happy to use it. (11-108)*

> *I'm even a bit frustrated about that I haven't had this available during, this is my first pregnancy and gestational diabetes, so I think it would have been really good. (11-109)*

One participant described how she really would like to use this kind of application, as she had felt left quite alone with her condition and thought that the application would help in knowing what to do and how to change her behavior.

> *It would be really good if I had that. Like immediately when you get the gestational diabetes diagnosis you would get like, you kind of could already start to track and measure and observe, because then it gets quite quickly like that, like if the values are as they should you get guided to different directions and then you get left quite alone, like what should I do and what should I change [– –] (11-109)*

Some participants liked that the application seemed personal. This participant commented on how it would feel nice to get a personalized good morning-message from the application. It should be noted that "Suvi" is not the name of the participant, but a

default name which was used in the application prototype.

> *Umm… well, [it would feel] nice, somehow nice to have these kind of "Good morning Suvi", and those kind of personal [– –] (11-104)*

One participant described that using the application in her daily life would feel natural. She linked the perception to the fact that she felt motivated to manage her GDM well.

> *Very natural. And when there is motivation anyway, like, I would want to handle this disease well. (11-103)*

Overall, the participants did not express many negative emotions related with the experience or idea of using the application, but there was one participant who thought that using the application would make her anxious. More specifically, she explained that not being always able to say no to food cravings and eating unhealthy treats would make her anxious if she would be participating in the intervention, since the ”lapses” then would be recorded by the application.

> *[– –] or when I get these cravings, beating them is actually really difficult. And that causes a little anxiety, when they become kind of, I don't know. Maybe I just get anxious more easily than the average person, but yeah. (11-107)*

Another participant suspected that using the application would feel a bit dull, but that knowledge of the application's purpose would make it bearable.

> *Well, in the beginning I'd probably feel bored. And maybe bored in the long run too, but when there is, you know that there is that reason why you use it, so, it would become quite bearable. (11-105)*

To sum up, participants associated mostly positive feelings with using the application. Only one person expressed a clearly negative feeling, as she felt that using the application could make her anxious. This person also had the least experience of using different mobile applications, which could be associated with her negative affective attitude towards the application.

Burden

The domain of burden reflects how much effort (e.g. time, cognitive effort) participating in the intervention is perceived to require (Sekhon et al., 2017). To get a picture of the perceived burden, we asked the participants what they thought it would require from them to use the application in their daily life, how much effort it would take and if they think they would have to learn something.

A very common opinion was that participating might require some effort in the beginning, as they would have to get used to the application and learn how to use it.

> *It would maybe take me a little while before I'd begin to use it, there has to be a moment to like, get to know it and kind of study it, since it isn't really like, that simple. (11-103)*

> *Well in the beginning, yeah [would require effort], but then it would probably be so natural that. (11-105)*

One participant did not think using the application would require any additional effort whatsoever, since she already was using so many.

> *Well, I don't feel that it would require any more, or since I anyway use all kinds of apps all the time so I don't, I don't feel that it would cause any additional effort. (11-104)*

A couple participants pointed out that having to calibrate the continuous glucose measurement sensor worn with the application by finger pricking would require effort.

> *Well probably yes if I would have to calibrate it, then it certainly requires effort. (11-101)*

On the other hand, for most people these measurements are necessary in any case when you are diagnosed with GDM. Without the continuous glucose sensor, multiple measurements per day by pricking, probably more than what is needed to calibrate the sensor, would be required. In other words, this burden would probably not be caused by the intervention, but by the disease itself. This participant mentioned how using the

application would require some effort multiple times a day, but also that GDM requires same kind of effort with or without the application.

> *Well probably it would require some small thinking and tapping multiple times a day, but I feel that this gestational diabetes does anyway, so. (11-109)*

Some participants brought up that using the application would require commitment and organizing the daily schedule in a specific way.

> *But it does require commitment, of course. (11-107)*
>
> *Well not effort but maybe just the time spent to it, requires just like, organizing the way you schedule your day [– –] (11-102)*

Some participants suspected that maintaining the habit of using the application as well as remembering to do so would become tedious tasks in the long run, especially if they were currently working.

> *That you would remember. For example, like now I'm eating, let's imagine that in that cafeteria at my workplace, and would start to explain to this device like, one deciliter of rice and so on… so remembering to do that, and bothering to do that. (11-105)*

One participant felt that while using the application would require effort, it would be *good* effort.

> *Well some amount of effort yeah, but maybe also like in a good way. Or somehow I get this kind of like, umm, like it sort of encourages you to do the good stuff and have healthy life habits [– –] (11-106)*

No-one expressed that using the application would require too much effort. The participants thought that some effort would be needed in the beginning as they would have to learn how to use the application and familiarize themselves with it. Some participants suspected that maintaining the habit of using the application and remembering to do so would become tiresome in the long run and require commitment. Being in the working life was thought to strengthen these concerns. Some of the effort

the participants associated with participating in the intervention would actually seem to be caused by the diagnosis itself, not by the intervention.

Ethicality

The construct of ethicality refers to the interventions compatibility with the individual's value system (Sekhon et al., 2017). We asked the participants what kind of values they think the application represents, and how well do they feel the application fits with their value system.

Most of the participants felt there was no conflict between the application and their individual value systems. Most often mentioned values were related to health and well-being, both of the mother and the baby, which is not surprising considering the nature of the application.

> *Probably like, common kind of like… is wellbeing a value? So increasing wellbeing, in that sense, well of course I hope to increase both my own and my child's wellbeing. (11-101)*

> *Well probably these kind of, values of a healthy and balanced life, or kind of like taking care of yourself [– –] (11-109)*

Some participants associated the well-being promoted by the application with certain gentleness in its approach, as opposed to "performing" well-being.

> *Well maybe that healthiness, and, I get this kind of feeling of these colors, what's the right word to describe it, sort of gentleness, or such. That you track, but not in a strict or pedantic manner. Maybe something like that, and kind of like, a well being expectant mother. (11-108)*

In addition to these most commonly mentioned values, some participants brought up values of independence and taking responsibility, maybe relating to the perception of self-management of GDM being the purpose of the application.

> *Maybe this kind of self-governance, managing oneself, independence, taking responsibility. (11-103)*

Interestingly enough, contracting with the previously stated perception of a ”gentle” application, one participant described the application as being too strict and demanding perfection from the intervention participants.

> *Well maybe I get a little this kind of strict feeling, like, somehow… like if you would meticulously follow it and be kind of perfect, so it feels that it is pretty impossible for anyone, kind of like, I don't know. But maybe it clashes with my own values a little, like you would kind of want to be a little gentler with yourself so when you are very precise with all those numbers and such, so then, there is a small conflict. (11-107)*

The perceived strictness seemed to be associated with the constant self-tracking and measuring, which was also a problem for some other participants. These participants felt that using the application would demand too much measuring, but on the other hand also recognized that measuring might be necessary for someone diagnosed with GDM regardless of the application. The problem with self-tracking seemed to be associated to a feeling of loss of autonomy and being controlled from the outside for some.

> *Well… compared to my values there's way too much measuring here. Like if you wouldn't need that, if you would be totally healthy and everything would be ok, then I surely wouldn't use it. (11-105)*

> *Maybe for me, why I haven't used an activity bracelet, I have maybe thought that it becomes too neurotic in a way, that you just track the numbers and kind of like, how I should manage my life from the outside. But if this has to do with gestational diabetes, then maybe it has to have a bit more of like, the kind of stricter measuring, so. (11-109)*

Some participants felt that the application did not represent any values that would feel conflicting to themselves, but recognized that to someone else, in this case the participant's grandmother, they might. This was also related to the sensors and measuring oneself.

> *Many, or some, for example my grandmother, were like how come you want to have all those sensors attached to you all the time, but I think it's just interesting and it doesn't really bother me, but I can imagine that some are too, like that. (11-104)*

In the interviews few value conflicts came up. Most commonly mentioned values represented by the application were health and well-being, which were associated with

certain gentleness by some. Even values relating to independence and individual responsibility were mentioned. Most conflicts seemed to be related to the measuring or self-tracking the application demands, but still, most of the participants had no problems with it. By looking at the background questionnaire we can see that the participant with the most negative view of the measuring and related values was also significantly less familiar with using different mobile applications than rest of the participants.

Based on the interviews it seems that the high amount of self-tracking divides opinions: some like it and some do not, and the rest do not really mind it as long as it serves a purpose. Having less experience with different mobile applications seems to be associated with more negative perceptions. This implies that a self-tracking-based approach may not be suitable for everyone, especially to persons less familiar with using different mobile applications. This is not ideal when planning an extensive intervention, but it should be noted that said self-tracking is not *only* related to the intervention: the mere condition of having GDM demands it, although to a smaller extent.

Intervention coherence

The concept of intervention coherence refers simply put to the individual's understanding of how the intervention is supposed to work. Intervention coherence reflects how the individual perceives the components of the intervention fit together with the intended aim of the intervention (Sekhon et al., 2017).

To investigate intervention coherence, we asked the participants to describe what in their opinion was the purpose of the application and what did they think of it. It seemed to be clear for the participants that the ultimate purpose was to help women with GDM manage their condition. This was to be expected, since they knew since when they were first recruited to the study that the end goal of this research project was to develop an application for patients with GDM. In the analysis the focus is on the participant's understanding of the different mechanisms through which the intervention aims to reach its goals.

Monitoring habits and helping to maintain a healthy lifestyle was mentioned in almost every interview.

> *Well encourage, like to maintain good life habits, or even to improve life habits.* (*11-105*)

Moreover, the participants often explicitly linked this to managing blood glucose and GDM. This participant discusses how the application would enable tracking how different habits and behaviors affect her glucose levels.

> *When there is this blood glucose tracking, like how different life habits affect it and how does the glucose graph look like, and this kind of maintaining good life habits, and that when you can set your own goals there so then kind of like following those, that have you succeeded in going to bed early or in going for a run so, that kind of tracking of life habits and maybe specifically in relation with gestational diabetes.* (*11-106*)

Some participants brought up that the application supports managing several aspects of the daily life at the same time, in contrast with just measuring blood glucose, which may be seen as the traditional approach by the participants.

> *Maybe like, managing multiple things. And maybe that's why there is a lot of stuff there, because it isn't only like here we are measuring your blood glucose. (11-103)*

The participants also suggested that motivating and encouraging would play an important part in how the application would support a healthy lifestyle, as well as drawing attention to some aspects in their daily lives.

> *But I think more of like, this kind of motivating to certain, drawing attention to things. For me it would be that. (11-102)*

Furthermore, the participants highlighted the patient's own role in her treatment. Self-management of GDM was seen as the starting point for the application.

> *Well the meaning is to treat gestational diabetes and kind of, maybe, or like self-management as a starting point, comes to mind. (11-104)*

> *Self-management and this kind of reflection [is the goal of the application]. (11-107)*

To conclude, participants of this study perceived that the purpose of the application is to support patients in self-management of GDM. The application would enable monitoring different life habits at the same time, as well as seeing the effect the habits and different behaviors have on the patient's blood glucose. In this way the application would motivate the patient to maintain a healthy lifestyle and thus help her manage her blood glucose levels and GDM. Based on these interviews, the participants have an excellent understanding of the purpose of this intervention.

Opportunity costs

This part refers to the benefits, profits or values the individual has to give up in order to engage in the intervention (Sekhon et al., 2017). We investigated opportunity costs by asking the participants what they feel they would have to give up in order to use the application in their daily lives.

Majority of the participants felt that there were no significant costs associated with using the application.

> *I don't feel that I should give up anything [– –] (11-102)*

> *Well probably the only thing [that I would have to give up] would be some pointless browsing of social media, I would kind of use that time to do it. So actually nothing. (11-108)*

In fact, some participants thought that using one single application with different functionalities would eliminate the need of using multiple applications, which would actually be a benefit instead of a cost.

> *No, I wouldn't have to [give up anything]. On the contrary, I like having everything kind of combined into this, so there aren't so many different ones then. (11-104)*

> *Well I don't really feel that I should give anything up, maybe then you would, or you would kind of combine into this all the several different ones you use, so then I wouldn't probably do a separate food diary into some other internet diary or, like. Wouldn't necessarily write blood*

> *glucose values down on some paper if I had them here, so. But maybe they aren't like that, or then you kind of don't give anything up but this would combine those things. (11-106)*

Some participants mentioned that using the application would take time, which they would consider as a cost.

> *Well, time. It does take time, so. But I don't think I should give up anything else. (11-105)*

One participant felt that in order to engage in the intervention by using the application, she would have to give up some of her freedom. On the other hand, she recognized that this had probably more to do with the diagnosis and associated lifestyle changes than the intervention itself.

> *A certain freedom of course, but well, it's just part of the deal if you're trying to take care of these things. (11-107)*

Summing up, majority of the participants associated no significant opportunity costs with engaging in the intervention. Some mentioned time spent using the application as a cost, which could imply that using the application was imagined to be too time consuming by some. On the other hand, some of the participants perceived that using this application with all the necessary functionalities for GDM and pregnancy would eliminate the need to use multiple applications, thus actually saving time and being a benefit instead of a cost. It should also be considered which of the perceived costs are actually associated with the intervention and which with the diagnosis itself.

Perceived effectiveness

Perceived effectiveness refers to the extent the individual perceives the intervention will achieve its purpose (Sekhon et al., 2017). This intervention is designed to target physical activity, diet, stress/recovery, sleeping and blood glucose management. Hence, we asked the participants whether they thought using this kind of application could help them to be more physically active, recover better, sleep enough and manage their blood glucose levels. We excluded diet from the interview, since the main diet-related component in the application, a speech enabled food diary, was not available in the prototype used in phase 1 of the study. Still, some of the participants did discuss diet,

mostly in relation to how being constantly able to see the development of their glucose levels would affect how they eat.

Most of the participants really liked the continuous glucose monitoring and that the application would enable seeing how different aspects in their lifestyle affect their glucose levels, thus helping them to manage their blood glucose. These participants mentioned that being able to see these trends could guide their behavior related to diet and physical activity.

> *Well specifically that you should get like, what you eat, or if you exercise, affect your blood glucose, so that guides your habits. (11-101)*
>
> *Well over all that, like, that it's continuous, if it would be continuous so that you see the whole day and, that kind of motivates to change your diet. (11-102)*

One participant disagreed, stating that she would not trust the values the continuous glucose monitoring would give her, based on her earlier experience of the sensor during the study period. This participant was the one who had rated her familiarity with using different mobile applications the lowest.

> *[– –] like at least in the beginning the values were very imprecise, but then towards the end they maybe evened a little. But well, I was left with a kind of, I'm not sure if I trust it or not. (11-107)*

Supporting physical activity with the application was the area the participants seemed to be most optimistic about: most of the participants felt that the application could help them to be more physically active, although some brought up that being physically active became increasingly difficult towards the end of the pregnancy.

> *Maybe in the beginning yeah, like when you are diagnosed with gestational diabetes, then at that point yeah. But now when I'm at the end [of the pregnancy], moving is so hard anyway, so. (11-108)*

Encouragement in making choices to increase everyday physical activity was mentioned by several participants. The participants also speculated that the effect in increasing physical activity could be modest for those people who already are quite active, but that

even they could be encouraged to do small things like take the stairs instead of the elevator.

> *Well it could probably encourage in that sense that when you have more sensors, or when you measure, so then you are kind of like okay, should I take the tram or should I walk. Maybe something like that, but otherwise of course when you exercise so much, so, probably not that much, that it would probably be like the kind of everyday thing, encourage you to take the stairs. (11-101)*

Measuring steps and having goals for physical activity were perceived as effective methods to increase physical activity by the participants. Steps were seen as a tangible and an easy to understand method to track physical activity. One participant noted that it would be helpful to see that the commonly heard goal of taking 10 000 steps daily would actually not be that hard to reach.

> *[– –] or like I think everyone has heard that you should take 10 000 steps every day, and when you would see that it's realistic, that it's not like you take 100 steps a day but that 8000 comes pretty easily, so surely then you would make it all the way to the goal. (11-103)*

It was also thought to be helpful that the application would remind the user of the goals she has set.

> *It would probably help yeah, that it would have those goals for you and it reminds you of them, so. (11-106)*

Sleep was perceived by several participants as something beyond their own control, and thus difficult to affect with or without an intervention. This was strongly related to being pregnant: the participants described how they had no trouble going to bed early or falling asleep but kept waking up several times during the night and slept poorly for this reason. Some participants had almost hostile reactions for an application telling them how badly they had slept when they felt that there was nothing to be done about it.

> *Well it's just so difficult in this phase. Because if you go to the toilet three times and have a foot cramp five times, then that is… and then the device says that you slept poorly, then I may feel like throwing it somewhere. (11-103)*

> *[– –] I don't know if you can do anything about it, that in this phase the sleep just doesn't come. Or like I have no problems falling asleep or going to bed, but then you just wake up to lights and noises and others so, you probably cannot change that with any application. But then of course if it was like that you just stay up and don't go to sleep then that's different. (11-104)*

Some participants were a bit more optimistic and thought that the application could help them to notice when they have slept too little and thus motivate them to try to sleep more. On the other hand, the positive feedback they would get from the application after a good night's sleep was also perceived as motivating.

> *Well yeah, this could help in that. Yeah, like if it would show, at least it works for me if I see that now I have slept too little in numbers, then that can have an effect, that then I think that I could maybe sleep more. (11-109)*

> *That when it, if you set certain goals there and then, or overall it tracks how much you have slept and then there's a smiley face when you have had 8.5 hours of sleep, so that is pretty motivating. (11-106)*

Support for stress management was perceived a bit irrelevant in the current situation by many, which was explained by the fact that most of the participants were on their maternity leave and did not experience a lot of stress at the time. This participant thought that the application might help her manage stress if she was currently working.

> *[– –] I don't feel that I have been very stressed lately anyway, but maybe if I'd still be working, then in that case it would be different, yeah. (11-104)*

Some participants had trouble grasping the concept of stress/recovery as something that could be measured and shown as numbers by the application, which seemed to decrease their trust in the stress levels shown by the application. This participant described how she did not understand why a sensor she used during the study period showed she was stressed out, since it was not how she felt at the moment.

> *[– –] I feel that I can't say even myself if I'm stressed and when or, and then there's the recovery too. It's somehow much easier to look at how many steps you have walked than something that's kind of fuzzy. [– –] it was so confusing, when the phone showed that I'm really stressed, and I didn't feel like it. (11-103)*

Most of the participants thought that the application could potentially help them with stress management, though they were not overly optimistic. The mechanism mentioned by most was that it could bring their attention to their potential stress, help them notice if their stress levels are high and pause to reflect on the matter. Several participants pointed out how any application itself could not *make* one relax or recover but could instead help to notice the stress or lack of recovery.

> *Maybe, it could, especially if it has like shown that the stress is really high, then at least it gets you thinking, if nothing else. I don't know if it helps in managing it, but at least you think about it for a small moment, even that is better than nothing. (11-107)*

> *[– –] but maybe it just awakens you to the fact that wait a minute, now I'm not recovering at all. But the actions start from yourself, no application can make you do that [– –] (11-102)*

This application-based intervention was perceived to be somewhat effective regarding its main goal (managing blood glucose levels) and all of the target behaviors: physical activity, diet, stress management and sleep. The participants did bring up some pregnancy related factors which negatively affected the perceived effectiveness. These were factors that would prevent them from engaging in the behaviors the application tries to support, for example their inability to exercise in the end of the pregnancy and problems in sleeping due to constantly waking up during the night because of cramps or such. Of all the target behaviors, increasing physical activity was the one the participants seemed to be most optimistic about.

Self-efficacy

Self-efficacy in the context of intervention acceptability describes if the individual feels confident in that they can perform the actions required to participate in the intervention (Sekhon et al., 2017). To get an overview of self-efficacy regarding this intervention, we asked the participants if they would know how to use the eMOM application independently.

In general, the participants felt that they would be able to use the application independently. For many this was linked to the perception that the application felt clear and easy to use.

> *Well probably pretty well, so. Like it feels clear to that extent, that you always know where you can save some measurement and like that, so it feels pretty clear, so probably would go pretty well independently. (11-106)*

Some felt that a brief instruction would be necessary, since some parts of the applications felt confusing or unclear.

> *It would go well, I'm sure, but let's say that if I started to use it right now then maybe someone should explain a bit like what, for example this calendar view, like what does it mean [– –] (11-102)*
>
> *Pretty well probably. There are some things that I would have to think for a bit, like what is this, for example this data part, like how do you read this, but I don't know if it would be that difficult to learn. Maybe if there was some kind of instruction on how to look at this [– –] (11-109)*

Still, most participants felt that this brief instruction would be enough to enable them to use the application independently. For some participants, their confidence in using the application in question seemed to be influenced by their overall familiarity with using mobile applications.

> *Really well probably, I have used similar ones and I don't think there would be any problems. (11-104)*
>
> *Maybe since I have used these kinds of apps some, like the ones you use to measure, or log for example, regarding monitoring your pregnancy, that you could set your weight and if you had any symptoms and such, so of course with that background I have using these. (11-106)*

This perception was supported by the data obtained from the background questionnaire. These two participants completely agreed with the statement ”I am accustomed to using different mobile applications”, while the participant with the lowest value answer, 2, expressed most doubt regarding her skills to use the application independently. She felt that a comprehensive orientation to the application use would be needed as well as a chance to quit using the application, implying a possibility that the application may not be suitable for everyone.

> *There would need to be a pretty good orientation in the beginning, and also a possibility to stop using it if it doesn't feel right, since the pregnancy is so long, so then like. (11-107)*

Summarizing, most of the participants felt confident in their skills to use the application independently, which was associated both with the perception of the application being clear and easy to use and the participants' familiarity with using different mobile applications. Some felt that there were parts in the application that felt unclear or confusing but did not doubt their ability to learn to use the application if given a brief instruction. One participant was more doubtful, which seemed to be associated with her overall unfamiliarity with using mobile applications.

6.3 Participant ideas for further development

During the interviews the participants also presented some ideas for further developing the application that would address their concerns regarding the application use. These ideas could give us hints about how to make the mHealth intervention even more acceptable from the participants' point of view.

One participant hoped that the application would provide a possibility to contact both technical support and healthcare personnel in case of she encountered problems. Furthermore, she thought that it would be useful if the application sent notifications in case the user should contact the maternity clinic, since she herself had often felt unsure of if her high glucose values had some kind of "natural" explanation or if something could actually be wrong, in which case she should consult the clinic.

> *That there would be a possibility to contact someone if there was a problem, like a call here if it doesn't work-section. And then maybe that you would have the contact information of a maternity clinic or such that you can, if something comes up, or that if you for example log the glucose values there would be, like now you have had three high values this week, you should contact the clinic, a notification like that. [– –] for example when I started measuring, I got these high values, but there was always some explanation for those, like now we ate lunch earlier than normally, so then I felt kind of unsure of if I should contact someone or not. (11-104)*

Providing a number to contact in case of technical difficulties with the application could be done relatively easily. Notifying the user of when to contact the maternity clinic is a

more difficult task, but it is worth considering. We would need to carefully consider the reliability of the data obtained from the different self-tracking sensors and emphasize that when in doubt, the users should always contact a healthcare professional, even if they had not been notified by the application. A lighter version of this mechanism could be for example to provide a list of issues worth consulting with a professional. Being able to answer to these requests of extra support could improve the acceptability of the intervention by strengthening the user's sense of self-efficacy. In addition, knowing when to contact a healthcare professional could add a sense of security, contributing to a positive affective attitude.

Some participants requested a screen with information on central functions of the application, that would guide them to the application use in the beginning. One participant even mentioned that this was what she expected would come up when tapping on the ”i” in the upper left corner of the main screen, which at the moment was planned to lead the user to a section with pregnancy information. This could be a potential place for the information screen.

> *At least that "I" there, I get the feeling that when you tap it then you would get an info screen right here. (11-106)*
>
> *Well, as I said, it's a little unclear and I'd add some, in the beginning when you create it, some kind of info thing there. (11-108)*

This idea would be relatively easy to realize, and could improve the acceptability of the intervention significantly by providing the ”brief instruction” that some participants felt was lacking and thus lowering their self-efficacy related to the application use. Also, the burden related to application use would be smaller, since most of the effort required was associated with learning to use the application. It would also be convenient that the participants could return to the information screen later if they had any issues with the application, rather than needing to contact any technical support.

Some participants were hoping for even further personalized content in the application. One participant pointed out that not every GDM patient have same priorities, but they may be struggling with different areas of managing their condition. She felt that it would be good if the application reflected these differences. Already now the application is designed to support the user's personal priorities by enabling the creation

of customized habits and goals, but this does not seem to be enough. Another participant requested for more personal recommendations. She also noted that there are changes in individual physiology during the pregnancy too and wondered if the recommendations could adapt.

> *Just that you could kind of modify it more to match everyone's own needs, like for example who has the blood glucose and who has the exercising, and that everyone wouldn't be, that everyone wouldn't be at the same level, but that you could adapt it a bit to match everyone's own, like what you can do and what you want to highlight. (11-107)*

> *Well mainly you would expect that you get these recommendations, so probably that what kind of recommendations there could be and how personal they could be, and how fast they also can adapt to that, to that changing, I guess that even the physiology changes some during the pregnancy, so that could be challenging. (11-109)*

Machine learning models planned to be developed in a later phase of the eMOM GDM study are going to answer to the demand of more personalized recommendations. In addition, we could consider how the application could be made to reflect the user's own priorities in her GDM management. There is already a chance to create personal goals, but maybe even the recommendations could reflect these priorities. How to react to the changing physiology during the course of pregnancy is a trickier question, which the medical experts of the project team should consider. If we are able to provide a more personalized application for the users through recommendations, the perceived effectiveness of the intervention could improve. The sense of having a personal application could also lead to more positive affective attitudes, since the participants commented on how the personal feeling they got from the application made them feel good.

7. Discussion

The purpose of this study was to examine the prospective acceptability of a mHealth intervention for self-managing gestational diabetes (GDM). GDM poses multiple health risk for both the mother and the child, and its prevalence is increasing globally. This is why developing effective interventions is highly important and investigating intervention acceptability holds a significant role in this. This study has chosen a novel

approach by utilizing the Theoretical framework of acceptability (Sekhon et al., 2017) in investigating the acceptability of an mHealth intervention.

The research questions of this study were
a) How do the potential recipients perceive the acceptability of the intervention in the different acceptability domains of the TFA (*affective attitude, burden, ethicality, intervention coherence, opportunity costs, perceived effectiveness* and *self-efficacy*) from a prospective point of view?
b) Are there any associations between the participants' technological experience and their perceptions of the acceptability of the intervention?
c) How could the acceptability of the intervention be improved?

Based on this study, the intervention seems to be quite acceptable regarding all of the acceptability domains of the TFA (Sekhon et al., 2017). Since the findings are different for every domain, each will be discussed separately.

Regarding *affective attitude*, participants associated mostly positive feelings with the idea of participating in the intervention. They explained how they would gladly use the application, and described how using it would feel for example ”natural” and ”nice”. Only one person expressed a clearly negative attitude, stating that she believed that using the application might make her anxious. This was related to self-tracking and to the fact that the application would record her inevitable ”lapses”. It has been noticed that not feeling able to act on the information gained by self-tracking can lead to negative emotions such as anxiety, guilt and sadness and lead to discontinuation of use of self-tracking tools (Epstein et al., 2017). To avoid dropout from the intervention, tools should be developed to address these potential negative feelings during the intervention. Regarding application design, encouraging the participants to set realistic, achievable goals for themselves and keeping the tone of the provided recommendations strictly supportive instead of blaming could help.

None of the participants thought that participating in the intervention would require too much effort, which indicates the *burden* was perceived to be manageable. Some effort was perceived to be required when learning to use the application, and some when trying to sustain the habit of using it. These findings are well in line with previous

research: Lazar, Koehler, Tanenbaum and Nguyen (2015) investigated reasons for use and abandonment of smart devices and found out that the time required to get into a routine of using the device was a common barrier for device use. They also noted that the effort of maintaining device use was a significant issue for their participants partly because they felt they did not gain enough value from it in return. This might explain why the participants in this study did not perceive the burden to be too great: even though using the application and all of the sensors definitely required some effort, the benefits gained would potentially make up for it. Making sure that the participants perceive the application as useful would therefore be important in designing any mHealth solutions: usefulness seems to undermine some of the experienced burden. To further reduce the burden associated with participating in this or any other mHealth intervention, the intervention recipients could be supported in developing a routine for the application use. (Lazar et al., 2015.)

Most of the participants felt the intervention matched with their personal values. The only issue with perceived *ethicality* of the intervention was related to the high amount of required self-tracking. Some participants liked it, some thought it was okay because it served a clear purpose, but some found it conflicting with their personal values. Part of the problem seemed to be a feeling of loss of autonomy and being controlled from the outside, which is interesting, since some participants on the contrary named independence, managing oneself and taking responsibility over one's own health as values the application represents. This reflects a certain ambivalence of the nature of self-tracking, where empowerment of patients is seen as one of its most important goals and virtues, but on the other hand it can be argued that it actually does the opposite by increasing the control of others who you share the data with (such as health professionals or friends) over oneself (Sharon, 2017). Based on this study both are equally true: different participants have different perceptions, depending for example on their previous experience of using mobile applications. Still, if several of the intervention participants feel a loss of autonomy when the intervention should be increasing it and supporting their self-management of their condition, it is problematic not only from the perspective of perceived ethicality, but also regarding the effectiveness of the intervention for these participants. Possible ways to prevent the feeling of autonomy loss could be emphasizing the actions taken to ensure data privacy

in the intervention and finding additional ways to support the feeling of autonomy. This is an important lesson for every mHealth application utilizing self-tracking.

The *intervention coherence* seems to be high, since the participants had a clear understanding both of the goal of the intervention (to support patients in self-management of GDM) and its intended mechanisms (enabling monitoring different habits and seeing their effects on the blood glucose as well as motivating the user to maintain a healthy lifestyle). According to a study by Moss-Morris and colleagues (2002), illness coherence, the extent to which the patient understands his or her illness as a whole, may influence their adjustment and response to their symptoms (Moss-Morris et al., 2002). Sekhon and colleagues (2017) have created a concept of intervention coherence based on this construct, and it is assumed to function in a similar way. It the assumption is correct, this is a very positive finding, since high intervention coherence could then predict a positive response to the intervention.

There were no significant *opportunity costs* associated with engaging in the intervention. Some participants mentioned time as a cost, but some also thought that the application could save them time since it would have all the necessary functionalities to manage both their GDM and pregnancy, thus eliminating the need of using multiple applications. Previous research indeed shows that different pregnancy applications are really popular: in an Australian survey study of 410 women, who either currently were or had recently been pregnant, 73% of the respondents had used at least one pregnancy application. It is also noteworthy that 57% had used between two and four different pregnancy applications, which means that among the respondents it was more common to use several pregnancy applications compared to just one. (Lupton & Pedersen, 2016.) Considering this, one application that covers the participants' pregnancy management needs in addition to their GDM management really seems more like an advantage than a cost. Keeping this in mind, it would be beneficial to include features for pregnancy management in future mHealth solutions for GDM as well. Some of the opportunity costs mentioned had to do more with the diagnosis itself than participating in the intervention, a finding that is present also in the perceptions of burden caused by the intervention. When conducting further studies on intervention acceptability, it should be ensured that the participants clearly understand which actions are required from them because of the intervention, and which are included in the standard treatment of their

condition.

The *perceived effectiveness* of the intervention seemed to be somewhat high regarding both its main goal (managing blood glucose levels) and all of the target behaviors: physical activity, diet, stress management and sleep. Of all the target behaviors, increasing physical activity was the one the participants seemed to be most optimistic about, and they could name several ways in which the application could help them to be more physically active. One explanation for this might be that physical activity measured in simple ways, such as steps, was experienced as more tangible by the participants than the other target behaviors: especially stress/recovery as a measurable item was confusing to some of the participants. One factor influencing the perceived effectiveness in a negative way was that there were some pregnancy related factors that the participants felt would prevent them from engaging in some of the behaviors the intervention is designed to support. These were for example not being able to exercise in the end of the pregnancy and difficulties sleeping through the night because of pregnancy related ailments, such as cramps. This kind of inability to act on the information provided by the application might cause some frustration (Lazar et al., 2015), as was noted in this study as well. To tackle this problem the recommendations provided by the application could for example be adapted according to the progression of the pregnancy. Some issues would probably still remain, since some of the barriers might be present throughout the pregnancy. In these cases, a possibility could be provided for the user to hide the data and recommendations that are of no use to them. These too are good points to keep in mind for designing future mHealth solutions for GDM.

Most participants had high perceptions of *self-efficacy* regarding independent application use. This was according to themselves associated with their previous experience with using mobile applications and the ease of use of the application. To some the application felt sometimes a bit confusing, a problem that they thought a brief instruction in the beginning of the intervention could probably solve. One participant was not as confident and thought that a comprehensive orientation would be needed in order for her to successfully use the application in her daily life. These doubts were possibly related to the fact that this interviewee had significantly less experience of using mobile applications than rest of the participants.

The extent to which the participant is accustomed to using different mobile applications seems to be associated with perceptions of acceptability, as predicted by the UTAUT model (Venkatesh et al., 2003). Based on the interviews, the role of technological experience seems to be largest in the TFA domains of affective attitude, self-efficacy and ethicality. The first two are in line with social psychological literature and hypotheses discussed in chapter 3.3. Bandura's self-efficacy theory (1977) explains how efficacy expectations are built on previous experiences, while the theory of planned behavior (Ajzen, 1991) implies that previous experience could play a part in the forming of affective attitudes through perceived behavioral control. The association between technological experience and the domain of ethicality is somewhat surprising since the theories reviewed earlier do not provide any explanation for this. It could be that individuals who feel that their values conflict with mobile applications including self-tracking also avoid using these applications and thus have less experience. According to Diepeveen and colleagues (2013) intervention acceptability is greatest for interventions that are perceived least intrusive. It could also be that this particular intervention is experienced as more intrusive by those who are not accustomed to using different mobile application and/or self-tracking. This might then reflect especially on the domain of ethicality, since as discussed above, the participants identified the high amount of required self-tracking as a factor with a negative influence on intervention ethicality.

Based on the UTAUT model (Venkatesh et al., 2003) the association between previous experience and the acceptability domain of burden was anticipated, but it was not visible in the interviews. None of the ten participants thought that the burden of participating in the intervention would be too great, so it could simply be that the association exists but was not visible in this data in which high levels of burden were not indicated.

Based on these results the intervention could be more acceptable for persons with higher levels of technological experience. To minimize the influence of previous experience, measures should be taken to support the acceptability domains in which its role seems to be largest: affective attitude, self-efficacy and ethicality. These results indicate that previous technological experience could also be associated with mHealth intervention acceptability in general. This finding is interesting, but it must be acknowledged that it

is not possible to draw any firm conclusions of the nature of these associations, since the number of participants was rather small and the approach qualitative. The issue should be examined more closely with a larger sample and possibly quantitative methods in order to see if previous technological experience actually affects perceptions of intervention acceptability.

In addition to the already presented ideas for further increasing intervention acceptability, the participants were also asked for their own ideas for developing the application. Some of the participants' ideas are easier to realize than others, but all provide good insight on possibilities of further improving the acceptability of the intervention. These were already discussed in the previous section and are now investigated in the light of existing literature.

Some participants hoped that the application would provide both technical and medical support if needed, which could be done for example by providing numbers to contact in case of any questions. In previous studies a need for easily accessible, reliable information about pregnancy-related health concerns has been noted and identified as a possibility for pregnancy mHealth (Goetz et al., 2017; Peyton et al., 2014), which is why it is not surprising that the pregnant users would want the application to function as a source for information regarding GDM as well. A couple participants requested an information screen to guide them with the application use in the beginning. This fits well with the findings regarding self-efficacy in this study, as several participants thought that independent use of the application would require only a brief instruction. Some of the participants hoped for further personalized content in the application, such as more personal recommendations. This finding is well in line with the findings of Goetz and colleagues (2017), who noted that pregnant users often expect personalized application content from their mHealth solutions.

Previous research showed that self-monitoring combined with other BCTs based on control theory (Carver & Scheier, 1982) is effective in lifestyle interventions targeting physical activity and diet (Michie. et al., 2009). The results from this study do not offer knowledge of intervention effectiveness, but they do indicate that from the perspective of acceptability a control theory-based approach is not without problems. Some participants had negative reactions to the high levels of self-monitoring promoted by the

application, and experienced inability to act on the information gained and loss of autonomy. Self-monitoring seemed to be associated with more negative acceptability perceptions in the domains of affective attitude and ethicality. The application's self-determination theory-based approach (Deci & Ryan, 2000) where recipient competence and autonomy are supported could be helpful in countering these problems, but the results from this study show that the mechanisms planned so far are not sufficient and further support for the basic needs of competence and autonomy is needed. A potential way of increasing autonomy support is giving a freedom of choice in the application use always when possible, for example by providing even greater freedom in setting personal goals and enabling choice in which behaviors to track, which was also requested by the participants. Additional support for competence could be provided for example by making sure the provided recommendations are easy to act up on and always expressed in a supportive tone.

Improving the theoretical framework of acceptability

The theoretical framework used to conceptualize acceptability in this study, the TFA (Sekhon et al., 2017), also has its limitations and there is still room for improving the framework. The definitions of different domains of acceptability are sometimes a bit poorly justified and not considered in the light of existing research and theory: for example, one of the variables which form the domain of affective attitude in the TFA is "*attitudinal measures*" (Sekhon et al., 2017), but in social psychological literature three distinct components of attitude are often recognized: affect, behavior and cognition (Breckler, 1984). Studying "attitude" could refer to any of these, which is why it should be clearly specified what kind of measures are being used. Another domain worth defining better is ethicality. The label *ethicality* is based on an Oxford Dictionary definition, *ethical* being defined in as "something morally good or correct", while ethicality in the framework is defined as the extent to which the intervention is compatible with the individual's *values*, implying that value is understood as something the individual considers morally good. However, in the systematic reviews used in creating the TFA, this domain is told to be reported as "*associated side effects with the intervention*" (Sekhon et al., 2017). There probably is a reasoning behind this connection made between side effects and values, but it is not explained in any way. Being clear and consistent on the terms and definitions used in the framework would go

long way to help avoid some confusion on concepts that can carry different meanings.

Furthermore, the TFA does not adequately account for social factors. In their review of previous attempts to define acceptability, Sekhon and colleagues (2017) discuss the concept of *social acceptability* but abandon it almost immediately. They describe how acceptability can be considered either as an individual or a collectively shared perspective of the intervention and end up with the first option in their own framework. What they seem to ignore is the fact that social factors influence the individual judgement of acceptability as well, which is actually what is meant by social acceptability in one of the articles they cite (Dillip et al., 2012). Therefore, it does not seem sensible to exclude the social dimension from the acceptability framework. There are indications of social factors influencing perceptions of acceptability in this study as well: when talking about intervention ethicality, one participant mentioned how her grandmother disliked her wearing ”all those sensors”. We know that social pressure like this affects our behavior: the theory of planned behavior (Ajzen, 1991) tells us how perceived social pressure (labeled as *subjective norm* in the theory) predicts intention, which in turn is a strong predictor for behavior. Social cognitive theory tells us that social norms generate self-regulation of behavior through the social consequences they carry (Bandura, 1998). According to these theories, social pressure could either encourage or discourage behavior needed to participate in the intervention. In this case the grandmother’s opinion did not seem to affect the participant’s behavior, but in a situation where the critique would come from a person whose opinion is considered highly important, for example from a partner, the situation could well be different. In the light of these social psychological theories I would suggest including an additional domain of acceptability in the TFA labeled *social influence* and defined as ”*the degree to which an individual perceives that important others believe he or she should participate in the intervention”*, after the previously presented Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003).

Limitations

Some practical limitations of the study are for example that three of the interviews were conducted by another research assistant. In these interviews some of the questions were not asked in a right way (e.g. ”How”-questions asked as yes or no-questions), leading to

some answers being less useful for the study. Furthermore, the fact that most of the participants were really familiar with using different mobile applications could have an impact on the results. It is probable that people not familiar with nor interested in mobile applications and self-tracking did not participate in the first place, so the results from this study might be too optimistic, although it is fortunate that one person with less experience participated. It is also possible that some meanings were lost in translation, since both the questions and the interview transcripts have been translated from English to Finnish.

It is also important to keep in mind that the participants were interacting with a interactive prototype, not the actual application. This means that for example stability of the actual application and potential technical issues could not yet be investigated, but this is typical for a user-centered design process and tests with low-fidelity prototypes are feasible in early stages of mHealth design (McCurdie et al., 2012). The fact that the browsing of the prototype in the interview situation was not fully structured and the experience was thus a bit different for every participant could influence their perceptions about the intervention as well: for example participants who were interested in a certain feature and examined it closely might have a different perception of the feature in question than those who missed it in their initial browsing and only looked at it briefly when the remaining features were presented by the research assistant. Regarding the study design, it is of course not possible to investigate the ”natural” use of the application in a laboratory setting, so some potential problems that might arise for example from interaction with the user’s environment could go unnoticed. Still, a recent study on usability testing found no significant differences between different methods of field testing and laboratory-based testing (Sauer et al., 2019).

Whether data saturation was reached is also worth considering. According to Fusch and Ness (2015) data saturation is reached when the study can be replicated, when it is no longer possible to obtain new information and when further coding no longer generates new themes. Guest, Bunce and Johnson (2006) also note that to achieve saturation in interview studies the study design should enable asking multiple participants the same questions, since otherwise data saturation becomes a moving target. In this study the questions asked were same with each participant, save for some additional questions asked in case some interesting new themes emerged during the interview. The study can

also be replicated, and since no new themes emerged when coding the 10th and the last interview, it can be assumed that data saturation was reached.

Further research

This study examined the potential recipients' perceptions of intervention acceptability before actually participating in the intervention. In other words, the perceptions are based on first impressions and might be different from the actual experiences of acceptability. This gives an important but limited view on intervention acceptability, and studies investigating concurrent and retrospective acceptability would still be needed in order to get a full picture of the acceptability of this intervention. Recipients of the intervention could be for example interviewed at some point during the intervention, and then again after the intervention period is complete. The results from these studies should be compared: if the perceptions of acceptability are significantly different at different timepoints, the reasons for this should be further investigated. To be able to compare the different temporal perspectives of acceptability, similar interview questions should be used in each study.

In future studies acceptability from the perspective of health care professionals such as maternity clinic nurses and doctors should be studied as well, since they will be involved if the application is going to be utilized in health care for GDM patients. Low acceptability on the intervention providers' side may negatively affect the delivery of the intervention thus lowering intervention fidelity (Bellg et al., 2004). The refined theoretical domains framework (Cane, O'Connor & Michie, 2012) that explains health care professionals' implementation of evidence-based practice provides support for this claim: the domains of this framework include ones similar to the domains of the TFA (Sekhon et al., 2017), such as emotion (*affective attitude*), beliefs about consequences (*perceived effectiveness*) and beliefs about capabilities (*self-efficacy*). Therefore, there could be reason to expect that acceptability in the domains of the TFA influences the delivery of the intervention, higher acceptability on the intervention providers' side being associated with higher intervention fidelity. Interviews for health care professionals on their experiences regarding the intervention could be organized both during and after the intervention to get information on concurrent and retrospective intervention acceptability from their point of view.

Conclusions

Based on the results of this study, the intervention has high prospective acceptability from the perspective of the potential participants. There is still room for improvement regarding all of the different domains of acceptability, except intervention coherence, and ideas for further improving the acceptability of this intervention have been extensively discussed. These ideas could be utilized to improve the intervention acceptability ahead of the next phases of the eMOM GDM study.

Several of the results are useful in mapping out design guidelines for GDM mHealth in general, and thus contribute to development of better mHealth for GDM. Some of the results are not specifically related to GDM or pregnancy. These can be utilized even in mHealth development in general.

Technological experience was recognized as a factor with potential associations with several domains of acceptability, low levels of previous experience seeming to be associated with more negative perceptions of intervention acceptability. Because of the small sample size of this study it is not possible to draw firm conclusions of the role of technological experience in participant perceptions of acceptability, but it should be investigated further, since there is no reason to expect the finding would be specific to this particular intervention. Knowing how technological experience is associated with perceptions of acceptability would be highly useful for developing effective and acceptable mHealth interventions of any kind.

References

Abraham, C., & Michie, S. (2008). A taxonomy of behavior change techniques used in interventions. *Health psychology*, *27*(3), 379–387

Abras, C., Maloney-Krichmar, D., & Preece, J. (2004). User-centered design. In Bainbridge, W. (Ed.), *Berkshire Encyclopedia of Human-Computer Interaction* (pp. 763–767). Massachusetts: Berkshire.

Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, *50*(2), 179–211.

American Diabetes Association (2004). Gestational diabetes mellitus. *Diabetes Care*, *27*(1), 88–90.

Bain, E., Crane, M., Tieu, J., Han, S., Crowther, C. A., & Middleton, P. (2015). Diet and exercise interventions for preventing gestational diabetes mellitus. *Cochrane database of systematic reviews*, *4*. Retrieved from https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD010443.pub2/pdf/CDSR/CD010443/CD010443.pdf

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological review*, *84*(2), 191–215.

Bandura, A. (1998). Health promotion from the perspective of social cognitive theory. *Psychology and health*, *13*(4), 623–649.

Bellamy, L., Casas, J.-P., Hingorani, A. D., & Williams, D. (2009). Type 2 diabetes mellitus after gestational diabetes: A systematic review and meta-analysis. *The Lancet*, *373,* 1773–1779.

Bellg, A. J., Borrelli, B., Resnick, B., Hecht, J., Minicucci, D. S., Ory, M., Ogedegbe, G., Orwig, D., Ernst, D., & Czajkowski, S. (2004). Enhancing treatment fidelity

in health behavior change studies: Best practices and recommendations from the NIH Behavior Change Consortium. *Health Psychology*, *23*(5), 443–451.

Bonoto, B. C., Araujo, V. E. de, Godoi, I. P., Lemos, L. L. de, Godman, B., Bennie, M., Diniz, L. M., & Junior, A. A. (2017). Efficacy of Mobile Apps to Support the Care of Patients With Diabetes Mellitus: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *JMIR MHealth and UHealth*, *5*(3), e4.

Breckler, S. J. (1984). Empirical validation of affect, behavior, and cognition as distinct components of attitude. *Journal of personality and social psychology*, *47*(6), 1191–1205.

Burkow, T. M., Vognild, L. K., Johnsen, E., Bratvold, A., & Risberg, M. J. (2018). Promoting exercise training and physical activity in daily life: A feasibility study of a virtual group intervention for behaviour change in COPD. *BMC Medical Informatics and Decision Making*, *18*(1), 136.

Cane, J., O'Connor, D., & Michie, S. (2012). Validation of the theoretical domains framework for use in behaviour change and implementation research. *Implementation science*, *7*(1), 37.

Carroll, J. K., Moorhead, A., Bond, R., LeBlanc, W. G., Petrella, R. J., & Fiscella, K. (2017). Who uses mobile phone health apps and does use matter? A secondary data analytics approach. *Journal of medical Internet research*, *19*(4), e125.

Carver, C. S., & Scheier, M. F. (1982). Control theory: A useful conceptual framework for personality–social, clinical, and health psychology. *Psychological bulletin*, *92*(1), 111–135.

Chen, H., Chai, Y., Dong, L., Niu, W., & Zhang, P. (2018). Effectiveness and Appropriateness of mHealth Interventions for Maternal and Child Health: Systematic Review. *JMIR MHealth and UHealth*, *6*(1), e7.

Craig, P., Dieppe, P., Macintyre, S., Michie, S., Nazareth, I., Petticrew, M., & Guidance, M. R. C. (2008). Developing and evaluating complex interventions: The new Medical Research Council guidance. *BMJ (Clinical Research Edition)*, *337*, 1655.

Deci, E. L., & Ryan, R. M. (2000). The" what" and" why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological inquiry*, *11*(4), 227–268.

De Jongh, T., Gurol-Urganci, I., Vodopivec-Jamsek, V., Car, J., & Atun, R. (2012). Mobile phone messaging for facilitating self-management of long-term illnesses. *Cochrane Database of Systematic Reviews*, *12*. Retrieved from https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD007459.pub2/pdf/CDSR/CD007459/CD007459.pdf

Diabetes Prevention Program Research Group (2003). Costs associated with the primary prevention of type 2 diabetes mellitus in the diabetes prevention program. Diabetes care, 26(1), 36–47.

Diepeveen, S., Ling, T., Suhrcke, M., Roland, M., & Marteau, T. M. (2013). Public acceptability of government intervention to change health-related behaviours: A systematic review and narrative synthesis. *BMC Public Health*, *13*(1), 756.

Dillip, A., Alba, S., Mshana, C., Hetzel, M. W., Lengeler, C., Mayumana, I., Schulze, A., Mshinda, H., Weiss, M. G., & Obrist, B. (2012). Acceptability–a neglected dimension of access to health care: Findings from a study on childhood convulsions in rural Tanzania. *BMC health services research*, *12*(1), 113.

Dumas, J. E., Lynch, A. M., Laughlin, J. E., Smith, E. P., & Prinz, R. J. (2001). Promoting intervention fidelity: Conceptual issues, methods, and preliminary results from the EARLY ALLIANCE prevention trial. *American journal of preventive medicine*, *20*(1), 38–47.

Epstein, D. A., Caraway, M., Johnston, C., Ping, A., Fogarty, J., & Munson, S. A. (2016). Beyond abandonment to next steps: Understanding and designing for life after personal informatics tool use. *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems,* 1109–1113.

Ericsson AB. (2015). *Ericsson mobility report: On the pulse of the networked society*. Retrieved from https://www.ericsson.com/assets/local/mobility report/documents/2015/ericsson-mobility-report-june-2015.pdf

Evans, M. K., & O'Brien, B. (2005). Gestational diabetes: the meaning of an at-risk pregnancy. *Qualitative Health Research*, *15*(1), 66–81.

Eyles, H., Jull, A., Dobson, R., Firestone, R., Whittaker, R., Te Morenga, L., Goodwin, D., & Mhurchu, C. N. (2016). Co-design of mHealth delivered interventions: A systematic review to assess key methods and processes. *Current Nutrition Reports*, *5*(3), 160–167.

Ferrara, A. (2007). Increasing prevalence of gestational diabetes mellitus: A public health perspective. *Diabetes care*, *30*(2), 141–146.

Flick, U. (2007). *Designing Qualitative Research*. London: SAGE.

Fusch, P. I., & Ness, L. R. (2015). Are we there yet? Data saturation in qualitative research. *The qualitative report*, *20*(9), 1408-1416.

Gestational diabetes. Current Care Guidelines. Working group set up by the Finnish Medical Society Duodecim, the Medical Advisory Board of the Finnish Diabetes Association and The Finnish Society of Obstetrics and Gynaecology

(2013). Helsinki: the Finnish Medical Society Duodecim. Available online: https://www.kaypahoito.fi/hoi50068#readmore

Gibbs, G. (2007). *Analysing qualitative data*. London: SAGE.

Gilinsky, A., Kirk, A., Hughes, A., & Lindsay, R. (2015). Lifestyle interventions for type 2 diabetes prevention in women with prior gestational diabetes: A systematic review and meta-analysis of behavioural, anthropometric and metabolic outcomes. *Preventive medicine reports*, *2*, 448–461.

Gitlin, L., & Czaja, S. (2015). *Behavioral intervention research: Designing, evaluating, and implementing*. New York: Springer.

Goetz, M., Muller, M., Matthies, L. M., Hansen, J., Doster, A., Szabo, A., Pauluschke-Frohlich, J., Abele, H., Sohn, C., Wallwiener, M., & Wallwiener, S. (2017). Perceptions of Patient Engagement Applications During Pregnancy: A Qualitative Assessment of the Patient's Perspective. *JMIR MHealth and UHealth*, *5*(5), e73.

Gould, N. J., Lorencatto, F., Stanworth, S. J., Michie, S., Prior, M. E., Glidewell, L., Grimshaw, J. M., & Francis, J. J. (2014). Application of theory to enhance audit and feedback interventions to increase the uptake of evidence-based transfusion practice: An intervention development protocol. *Implementation Science*, *9*(1), 92.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field methods*, *18*(1), 59–82.

Herring, S. J., Cruice, J. F., Bennett, G. G., Rose, M. Z., Davey, A., & Foster, G. D. (2016). Preventing excessive gestational weight gain among African American women: A randomized clinical trial. *Obesity*, *24*(1), 30–36.

Horner, S., Rew, L., & Torres, R. (2006). Enhancing intervention fidelity: A means of strengthening study impact. *Journal for Specialists in Pediatric Nursing*, *11*(2), 80–89.

Hou, C., Carter, B., Hewitt, J., Francisa, T., & Mayor, S. (2016). Do Mobile Phone Applications Improve Glycemic Control (HbA1c) in the Self-management of Diabetes? A Systematic Review, Meta-analysis, and GRADE of 14 Randomized Trials. *Diabetes Care*, *39*(11), 2089–2095.

Hu, G., Tian, H., Zhang, F., Liu, H., Zhang, C., Zhang, S., Wang, L., Liu, G., Yu, Z., Yang, X., Qi, L., Zhang, C., Wang, H., Li, M., Leng, J., Li, Y., Dong, L., & Tuomilehto, J. (2012). Tianjin Gestational Diabetes Mellitus Prevention Program: Study design, methods, and 1-year interim report on the feasibility of lifestyle intervention program. *Diabetes Research and Clinical Practice*, 98(3), 508–517.

Huang, Z., Soljak, M., Boehm, B. O., & Car, J. (2018). Clinical relevance of smartphone apps for diabetes management: A global overview. *Diabetes/metabolism research and reviews*, *34*(4), 2990.

Kardas, P., & Lewandowski, K. (2015). Type 2 diabetes patients assessment of the COMODITY12 mHealth system. *EAI Endorsed Transactions on Pervasive Health and Technology*, *1*(4), 1.

Koivusalo, S. B., Rono, K., Klemetti, M. M., Roine, R. P., Lindstrom, J., Erkkola, M., Kaaja, R. J., Poyhonen-Alho, M., Tiitinen, A., Huvinen, E., Andersson, S., Laivuori, H., Valkama, A., Meinila, J., Kautiainen, H., Eriksson, J. G., & Stach-Lempinen, B. (2016). Gestational Diabetes Mellitus Can Be Prevented by Lifestyle Intervention: The Finnish Gestational Diabetes Prevention Study (RADIEL): A Randomized Controlled Trial. *Diabetes Care*, *39*(1), 24–30.

Lazar, A., Koehler, C., Tanenbaum, J., & Nguyen, D. H. (2015). Why we use and abandon smart devices. *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing*, 635–646.

Lupton, D., & Pedersen, S. (2016). An Australian survey of women's use of pregnancy and parenting apps. *Women and birth*, *29*(4), 368–375.

Mackillop, L., Hirst, J. E., Bartlett, K. J., Birks, J. S., Clifton, L., Farmer, A. J., Gibson, O., Kenworthy, Y., Levy, J. C., Loerup, L., Rivero-Arias, O., Ming, W. K., Velardo, C., & Tarassenko, L. (2018). Comparing the Efficacy of a Mobile Phone-Based Blood Glucose Management System With Standard Clinic Care in Women With Gestational Diabetes: Randomized Controlled Trial. *JMIR MHealth and UHealth*, *6*(3), e71.

McCurdie, T., Taneva, S., Casselman, M., Yeung, M., McDaniel, C., Ho, W., & Cafazzo, J. (2012). mHealth consumer apps: The case for user-centered design. *Biomedical instrumentation & technology*, *46*(2), 49–56.

Metzger, B. E., Coustan, D. R., & Organizing Committee (1998). Summary and recommendations of the fourth international workshop-conference on gestational diabetes mellitus. *Diabetes care*, *21*, B161.

Michie, S. (2008). Designing and implementing behaviour change interventions to improve population health. *Journal of Health Services Research & Policy*, *13*(3), 64–69.

Michie, S., Abraham, C., Whittington, C., McAteer, J., & Gupta, S. (2009). Effective techniques in healthy eating and physical activity interventions: A meta-regression. *Health Psychology*, *28*(6), 690–701.

Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., Eccles, M. P., Cane, J., & Wood, C. E. (2013). The behavior change technique

taxonomy (v1) of 93 hierarchically clustered techniques: Building an international consensus for the reporting of behavior change interventions. *Annals of behavioral medicine*, *46*(1), 81–95.

Moss-Morris, R., Weinman, J., Petrie, K., Horne, R., Cameron, L., & Buick, D. (2002). The revised illness perception questionnaire (IPQ-R). *Psychology and health*, *17*(1), 1–16.

Mulligan, K., Steed, L., & Newman, S. P. (2009). *Chronic Physical Illness: Self-management and Behavioural Interventions*. UK: McGraw-Hill Education.

Overdijkink, S. B., Velu, A. V., Rosman, A. N., Beukering, M. D. van, Kok, M., & Steegers-Theunissen, R. P. (2018). The Usability and Effectiveness of Mobile Health Technology-Based Lifestyle and Medical Intervention Apps Supporting Health Care During Pregnancy: Systematic Review. *JMIR MHealth and UHealth*, *6*(4), e109.

Pedersen, A. L. W., Maindal, H. T., & Juul, L. (2017). How to prevent type 2 diabetes in women with previous gestational diabetes? A systematic review of behavioural interventions. *Primary care diabetes*, *11*(5), 403–413.

Petticrew, M. (2011). When are complex interventions 'complex'? When are simple interventions 'simple'? *European Journal of Public Health, 21*(4), 397–398.

Peyton, T., Poole, E., Reddy, M., Kraschnewski, J., & Chuang, C. (2014). Every pregnancy is different: Designing mHealth for the pregnancy ecology. *Proceedings of the 2014 conference on Designing interactive systems*, 577–586.

Phelan, S. (2010). Pregnancy: A "teachable moment" for weight control and obesity prevention. *American Journal of Obstetrics and Gynecology*, *202*(2), 135.

Puhkala, J., Kinnunen, T. I., Vasankari, T., Kukkonen-Harjula, K., Raitanen, J., & Luoto, R. (2013). Prevalence of metabolic syndrome one year after delivery in

Finnish women at increased risk for gestational diabetes mellitus during pregnancy. *Journal of Pregnancy*, 139049.

Rixon, L., Baron, J., McGale, N., Lorencatto, F., Francis, J., & Davies, A. (2016). Methods used to address fidelity of receipt in health intervention research: A citation analysis and systematic review. *BMC health services research*, *16*(1), 663.

Rönö, K., Stach-Lempinen, B., Klemetti, M. M., Kaaja, R. J., Pöyhönen-Alho, M., Eriksson, J. G., & Koivusalo, S. B. (2014). Prevention of gestational diabetes through lifestyle intervention: Study design and methods of a Finnish randomized controlled multicenter trial (RADIEL). *BMC pregnancy and childbirth*, *14*(1), 70.

Sauer, J., Sonderegger, A., Heyden, K., Biller, J., Klotz, J., & Uebelbacher, A. (2019). Extra-laboratorial usability tests: An empirical comparison of remote and classical field testing with lab testing. *Applied ergonomics*, *74*, 85–96.

Sekhon, M., Cartwright, M., & Francis, J. J. (2017). Acceptability of healthcare interventions: An overview of reviews and development of a theoretical framework. *BMC health services research*, *17*(1), 88.

Sharon, T. (2017). Self-tracking for health and the quantified self: Re-articulating autonomy, solidarity, and authenticity in an age of personalized healthcare. *Philosophy & Technology*, *30*(1), 93–121.

Silva, M. N., Markland, D., Carraca, E. V., Vieira, P. N., Coutinho, S. R., Minderico, C. S., Matos, M. G., Sardinha, L. B., & Teixeira, P. J. (2011). Exercise autonomous motivation predicts 3-yr weight loss in women. *Medicine & Science in Sports & Exercise*, *43*(4), 728–737.

Stawarz, K., Cox, A. L., & Blandford, A. (2015). Beyond self-tracking and reminders: Designing smartphone apps that support habit formation. *Proceedings of the 33rd annual ACM conference on human factors in computing systems*, 2653–2662.

Teixeira, P. J., Carraça, E. V., Markland, D., Silva, M. N., & Ryan, R. M. (2012). Exercise, physical activity, and self-determination theory: A systematic review. *International journal of behavioral nutrition and physical activity*, *9*(1), 78.

Tuomi, J. & Sarajärvi, A. (2009). *Laadullinen tutkimus ja sisällönanalyysi* (6th ed.). Helsinki: Tammi.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *Management Information Systems Quarterly*, *27*(3), 425–478.

Webb, T. L., Joseph, J., Yardley, L., & Michie, S. (2010). Using the internet to promote health behavior change: A systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy. *Journal of Medical Internet Research*, *12*(1), e4.

WHO (2020). *EHealth at WHO*. Retrieved from https://www.who.int/ehealth/about/en/

Williams, G. C., Freedman, Z. R., & Deci, E. L. (1998). Supporting autonomy to motivate patients with diabetes for glucose control. *Diabetes care*, *21*(10), 1644–1651.

Appendices

Appendix 1: Interview questions in original language

This appendix includes the interview questions in their original language (Finnish).

- Affective attitude:
    - Mitä mieltä olet sovelluksesta? Miltä sen käyttäminen tuntuu?
    - Miltä tuntuisi ajatuksena käyttää sovellusta päivittäisessä elämässäsi?
- Burden:
    - Jos käyttäisit sovellusta päivittäisessä elämässäsi, mitä luulet, että se vaatisi sinulta?
        - Mitä sinun pitäisi oppia?
        - Kuinka paljon vaivaa se vaatisi sinulta?
- Ethicality:
    - Minkälaisia arvoja sovellus mielestäsi edustaa?
    - Miten hyvin koet sovelluksen sopivan yhteen omien arvojesi kanssa?
- Intervention coherence:
    - Mikä luulet, että on sovelluksen tarkoitus? Mitä ajattelet siitä?
- Opportunity costs:
    - Mistä sinun pitäisi luopua voidaksesi käyttää sovellusta päivittäisessä elämässäsi?
- Perceived effectiveness:
    - Miten luulet, että sovellus voisi auttaa sinua…
        - Verensokerin hallinnassa?
        - Tukemaan palautumista ja stressinhallintaa?
        - Liikkumaan enemmän/ylläpitämään riittävää liikunnan tasoa?
        - Nukkumaan riittävästi?
- Self-efficacy:
    - Miten luulet, että sovelluksen itsenäinen käyttö sujuisi sinulta?

Appendix 2: Interview quotes in original language

This appendix includes the quotes from the interviews in their original language (Finnish).

Quotes from chapter 6.2

Affective attitude

Vaan kyl se niinku, sit taas myös, siin on niin paljon mielenkiintosii asioita. Et sen takia varmasti ihan mielellään sitte myöskin käyttäis. (11-108)

Kyllä vähän jopa silleen harmittaa ettei oo itellä ollu käytössä nyt tän, tää on mun eka raskaus ja eka raskausdiabetes, niin ois ollu kyl varmaan tosi hyvä. (11-109)

Se ois tosi hyvä, jos ois semmonen. Et just heti ku saa sen raskausdiabetesdiagnoosin nii sais niinku, tavallaan vois alkaa jo vähän seurailee ja mittailee ja kattelee, koska sithän se aika nopeesti tulee siin että, se että niinku oot pitäny, jos siin on arvot kohallaa nii sitte sua ohjaillaan eri suuntiin ja sit siinä jää aika yksin et no mitä mun pitää tehä ja mitä mä muokkaisin [– –] (11-109)

Mm... no, [tuntuisi] kivalta, jotenki kiva et on tämmösiä ”Hyvää huomenta Suvi” ja, sellanen niinku henkilökohtanen [– –] (11-104)

Ihan tosi luontevalta. Ja kun on kuitenki motivaatio, niinku et haluais hoitaa tän taudin hyvin. (11-103)

[– –] tai sit ku tulee niit mielitekoja niin niist kieltäytyminen on kyl tosi vaikeeta. Ja se aiheuttaa vähän ahdistusta sitte et ku ne tulee tavallaan niinkun, tavallaan, en mä tiedä. Ehkä mä oon vaan normaalia helpommin ahdistuva, mut tällee. (11-107)

No alkuun musta tuntuis varmaan tylsältä. Ja voi olla et pidemmän päälleki tylsältä, mut sit ku siin on, tietää et siin on kuitenki se ajatus taustalla miks käytetään nii, kyllä se niinku muuttuis hyvinki siedettäväks ja silleen. (11-105)

Burden

Voi olla et mulla menis niinku vähän aikaa ennenku mä ottaisin sen käyttöön, et pitää olla just joku hyvä hetki et siinä niinku tutustuu ja vähän niinku opiskelee, et se ei ihan oo semmonen, ihan simppeli. (11-103)

No alkuun joo [vaatisi vaivaa], mut sit se varmaan tulis nii luonnostaan et. (11-105)

Tota, en mä koe että se vaatis mitenkää enempää, tai muutenkin käyttää kaikenlaisia apseja koko ajan nii ei, en mä koe että tosta ois mitään sellai, ylimäärästä hommaa. (11-104)

No kyllä varmaan sit jos pitää sitä kalibroida niin kylhän se sit vaatii tietysti vaivaa. (11-101)

No kyl se varmaan niinku monta kertaa päivässä vaatis jotain pientä funtsimista ja naputteluu mutta, mut niin tää muutenki tää raskausdiabetes vähän niinku tuntuu vaativan että, et sillä lailla. (11-109)

Mut kyl toi sitoutumist niinku vaatii tietysti. (11-107)

No ei se nyt vaivaa mut ehkä vaan just se ajankäyttö niinku siihen, vaatii vaan niinku, sellast organisointii sillee niinku miten päivän muutenki rytmittää [– –] (11-102)

No että muistais. Vaikka että nyt mä syön, kuvitellaan et siel työpaikkaruokalassa ja, alkaisin selostaa tälle laitteelle et yksi desi riisiä ja noin... nii se muistaminen, ja sit se viittiminen. (11-105)

No jonkun verran vaivaa joo, mut et ehkä silleen myöskin ihan hyvällä tavalla. Tai jotenki itellä tulee myöski vähän semmonen, mm, niinku et sit se toisaalta kannustaa niihin hyviin juttuihin ja hyviin elämäntapoihin [– –] (11-106)

Ethicality

Kyl se varmaan sellasii niinku, yleistä tämmöstä niinkun, onks hyvinvointi mikään arvo? Mut siis hyvinvointia lisäämistä, niin siinä mieles, et totta kai itellä on niinku toiveena lisätä omaa että lapsen hyvinvointia. (11-101)

No varmaan tämmöst terveellisen ja tasapainoisen elämän niinku arvoja, tai jotenki semmosta itsestä huolehtimisen [– –] (11-109)

No ehkä sitä terveellisyyttä ja, semmost, mä koen täst värimaailmast tulee sellanen niinkun, millähän sanal mä kuvailisin sitä, semmonen lempeys, tai semmonen että. Et seurataan, mutta ei silleen hampaat irvessä tai pilkkua viilaten. Ehkä jotain semmosta, ja sellanen niinku, hyvin voiva odottava. (11-108)

Ehkä niinku just tää tämmönen niinku itseohjautuvuus, itsensä johtaminen, itsenäisyys, vastuunottaminen itse. (11-103)

No ehkä tost tulee pikkasen semmonen niinku tiukkis-fiilis, semmonen että, jotenki... sillee et sitä niinku orjallisesti niinku noudattais ja et ois niinku täydellinen niin tuntuu et se on niinku aika mahdoton ehkä kellekään, et vähän semmonen niinkun, en mä osaa sanoo. Mut niinku ehkä vähän sotii silleen omien arvojen, et tavallaan jotenki haluis olla vähän lempeempi itellensä et sitte et on niinku tosi tarkka noiden kaikkien numeroiden kaa ja näin niin sitte että, siin on pieni ristiriita. (11-107)

No... mun arvoihin verrattuna nii täs on ihan liikaa mittausta. Et jos ei niinku tarviis tommosta mihinkään, ois tavallaan täysin terve ja kaikki ois kunnossa, nii en varmasti käyttäis. (11-105)

Ehkä mulle, miks mä en oo käyttäny aktiivisuusranneketta nii mä oon ehkä aatellu et sit siit tulee liian semmosta neuroottista, et seuraa vaan kokoajan niit numeroita ja ulkoopäin vähän niinku et miten mun pitäis hallinnoida mun elämää mut. Mut jos tää niinku liittyy tähän raskausdiabetekseen nii ehkä sitte täs pitääkin olla vähä enemmän semmost, iha semmost tarkempaa seurantaa että. (11-109)

Just niinku monet, tai sillai jotkut, just vaikka isoäiti oli silleen et miten sä nyt haluut et sussa on tollasia mittareita kokoajan, mutta mun mielestä se on vaan silleen mielenkiintosta ja ei niinkun haittaa mua, mutta voin kuvitella et jotkut on liian, sillee. (11-104)

Intervention coherence

No kannustaa, niinku pitämään hyviä elämäntapoja yllä, tai parantamaan jopa elämäntapoja. (*11-105*)

Ku täs on tää verensokeriseuranta, et miten eri elämäntavat vaikuttaa siihen missä se sitte se sokerikäyrä menee, tota ja semmonen sit niinkun hyvien elämäntapojen ylläpito, ja semmonen et ku sinne niit omia tavotteita pystyy laittamaan nii tavallaan sit niiden niinku, semmonen seuranta et onko nyt onnistunu sit menee ajoissa nukkumaan tai käymään jossain lenkillä nii, semmonen elämäntapojen seuranta ja sit nimenomaan ehkä suhteessa siihen raskausdiabetekseen. (*11-106*)

Ehkä tota, niinku hallita montaa asiaa. Ja sen takia siinä ehkä myös on sitä kamaa niin paljon, ku se ei oo vaan silleen että tässä mittaamme sun verensokeria. *(11-103)*

Mutta enemmän mul tulee just se semmonen niinku motivoiminen tiettyihin, kiinnittää huomioo asioihin. Mulle se olis sitä. (11-102)

No tarkotus on että hoidetaan raskausidabetesta ja tavallaan, ehkä, tai just sillai oma hoito niinkun lähtökohtana, tulee mieleen. (11-104)

Oma seuranta ja tällanen reflektointi [on sovelluksen tarkoitus]. (11-107)

Opportunity costs

En koe mitää et pitäis luopuu mistään [– –] (11-102)

No varmaan ainut asia joku turhan sosiaalisen median selaaminen, tavallaan käyttäis sen ajan sit siihen tekemiseen. Et ei oikeestaan mistään. (11-108)

Eei, ei kyllä tarvii [luopua mistään]. Päinvastoin must on kiva et tähän on vähän niinku koottuna ne kaikki, että ei oo sit nii montaa eri kohtaa että. (11-104)

No ei nyt tunnu silleen mitenkään hirveesti että pitäis luopua mistään, et ehkä sitte tulis, tai tulis niinkun yhdistettyä tähän se mitä nyt sitte käyttää johonki useempaan eri, et sit varmaan en tekis erillistä ruokapäiväkirjaa johonkin toiseen nettipäiväkirjaan tai, tai tota. Välttämättä kirjottais verensokereita johonki paperille ylös jos ne on mulla täällä, et tota. Mut et ne ei oo ehkä semmosia, tai tavallaanhan siinä nyt ei sit luovu vaan tää yhdistäis niitä. (11-106)

No ajasta. Kyllähän toi nyt aikaa vie, et. No, en mä usko että muusta pitäis luopuu. (11-105)

Tietystä vapaudesta tietysti, mutta tota, se nyt kuuluu asiaan jos yrittää pitää huolta näistä. (11-107)

Perceived effectiveness

No siis nimenomaan et kylhän tos niinku pitäis saada just se et mitä sä syöt, tai liikut, vaikuttaa siihen sun verensokeriin, niin se ohjaa sun tapoja. (11-101)

No just, siis ylipäätänsä se, tota, et se on jatkuva jos se niinku tossaki tulis olee se jatkuva, et ihan koko päivän näät ja just se, tavallaan se motivoi siihen ruokavalion muutokseen. (11-102)

[– –] niinku ainaki aluks ne arvot oli kyl ihan mitä sattuu, mut sit niinku loppuu kohden ne ehkä vähän tasottu. Mutta tota, et mul jäi siit vähän semmonen et mä en oo ihan varma luotanks mä siihen vai en. (11-107)

Ehkä sit siin alus joo, niinku tyyliin et kun raskausdiabetes todettais, niin siin kohti varmaan sitte. Mut et nyt ku on itellä niin loppu menossa nii liikkuminen on muutenki nii vaikeeta, nii." (11-108)
"No kyllä se varmaan vois kannustaa siinä mielessä et sit ku sul on noit mittareita enemmän niin, tai mittaat, niin nii silleen tavallaan et okei, meenks mä ratikalla tai kävelenks mä. Ehkä sen tyyppisiä, mutta muuten tietysti ku urheilee niin paljon nii, ei varmaan hirveesti, et se ois sit ehkä jotain semmosta arkipäivän, kannustaa kävelemään portaat. (11-101)

[– –] tai siis kylhän kaikki varmaan on kuullu sen että 10 000 askelta pitäis kävellä joka päivä ja, sit niinku näkis että se on niinku realistista, että se ei oo mikään että otan 100 askelta päivästä vaan sieltä tulee 8000 aika helposti, niin ihan varmasti sit vetäis sen tavoitteeseen asti. (11-103)

Kyl se varmasti auttais, just että ku siel ois niitä tavotteita itelle ja sit se muistuttelee niistä niin tota. (11-106)

No ku se on just nii hankala nyt tässä vaiheessa. Ku jos kolme kertaa käy vessassa ja viis kertaa on jalkakramppi nii se on... Ja sitte kone sanoo et nukuit huonosti niin kyllä tekee ehkä mieli heittää se johonki. (11-103)

[– –] en mä tiiä pystyyks sitä millään vaikuttamaan et nyt täs vaiheessa ei vaan enää tuu uni. Tai että niinku nukahtamisen kanssa ei oo mitään ongelmaa eikä nukkumaanmenossa mut sit vaan herää valoon ja ääniin ja muihin nii, ei sitä ehkä voi millään sovelluksella muuttaa. Mut tietenki sit jos ois semmonen et kukkuis vaan eikä menis nukkuu niin eri asia sitte. (11-104)

No joo, tää vois auttaa kyl siinä. Joo, et jos siin näkyy, ainaki mulla silleen toimii et jos mä nään numeroina sen että nyt sä oot nukkunu liian vähän nii kyl se silleen voi vaikuttaa, et sit mä aattelen et no vois ehkä nukkuu enemmän. (11-109)

Että ku se, jos sinne pistää tietyt tavotteet ja sitte, tai ylipäätään se seuraa et paljon nyt on nukkunu ja sit tääl on tämmönen hymynaama kun on kahdeksan ja puoli tuntia unta nii, nii kyl seki on ihan semmonen kannustava. (11-106)

[– –] mä en nyt koe ollleni hirveen stressaantunu tässä muutenkaan mutta, mutta ehkä just jos vielä olis töissä niin sitte, sit siinä tapaukses ois eri asia, joo. (11-104)

[– –] ku musta tuntuu että en mä osaa itekään sanoa et onko stressaantunu ja milloin vai, ja sit se palautuminenkin. Se on jotenkin paljon helpompaa kattoo että paljonko on kävelly askeleita ku tommosta vähän hyhmästä. [– –] se oli niin hämmentävää kun se puhelin näyttää et mä oon nyt ihan hirveen stressaantunu, sit ku se oma olo ei. (11-103)

Ehkä, kyl se, varsinki jos se on niinku näyttäny sitä et se on siel huipussa se stressi nii kyl se ainaki niinku pistää miettii, jos ei nyt mitään muuta nii ainaki sitte. Sitä mä en tiiä niinku hallitsee, mut ainaki niinku ajatuksen tasolla et sitä niinku pienen hetken miettii, nii seki on parempi ku ei mitään. (11-107)

[– –] mut ehkä vaan se herättelee sua niinku siihen et hetkinen että, nythän mä en niinku palaudu ollenkaan. Mut kyl ne teot lähtee sit itestä, ei siihen mikään sovellus pakota [– –] (11-102)

Self-efficacy

Kyl varmaan ihan hyvin että, et tota. Et kyl tää sen verran tuntu ihan tämmöselt selkeeltä, et aina milloin mistäki kohasta saa jonku tota, saa jonkun mittauksen tallennettua ja näin nii tämmönen, tuntuu kyllä aika selkeeltä, et varmaan ihan hyvin sujuis itsenäisesti. (11-106)

Siis varmasti hyvin, mutta kyl, sanotaan et mä ottasin nyt just käyttöön sen nii ehkä semmonen et joku selittää vähän mitä niissä, just tää kalenterinäkymä se siinä mitä se meinaa [– –] (11-102)

Ihan, ihan hyvin varmaan. On täs jotain tietty mitä pitäis vähän niinku pähkäillä et no mikäs tää nyt on tää, tää niinku datan vaikka, datakohta et miten tätä tulkitaan mut en mä nyt tiedä onks se niin vaikee oppii. Ehkä jos siihen ois sit joku ohjeistus viel et miten mä tätä katon [– –] (11-109)

Varmasti tosi hyvin, oon käyttäny samantapasii ja. En usko et ois mitään ongelmaa. (11-104)

Et ehkä tietysti iteki on siis jonkun verran käyttäny just tämmösiä jotakin niinku sovellustyylisiä, niinku et mihin mitataan, tai mihin pistetään vaikka siis just että raskauden seurannan kannalta että on voinu pistää painon ja oliko joku oire ja tämmönen nii, sillä taustalla tietysti et ite on jonkun verran jotai semmosia käyttäny. (11-106)

Aika hyvä perehdytys ehkä pitäis sit olla ainaki alkuun, ja sitte mahollisuus sit niinku vaikka lopettaa se käyttö jos se niinku ei tunnukaan omalta, mut ku raskausaika on nii pitkä nii sitte tota. (11-107)

Quotes from chapter 6.3

Et ois niinku joku mahis ottaa yhteyttä johonki sit jos on joku ongelma, semmonen soita tänne jos ei toimi-kohta. Ja sit ehkä et ois niinku neuvolan yhteystiedot tai jotkut semmoset mihin, et sit jos tulee jotain, tai että jos siihen vaikka merkkaa niitä sokereita et olis nii että nyt sulla on tullut kolme korkeeta tällä viikolla, ota yhteyttä neuvolaan, semmonen huomautus. [– –] esimerkiks silloin ku mä aloin heti mittaa, nii mul tuli niit tavallaan korkeit sokereita, mut niille oli aina joku selitys että meil nyt oli lounas puol tuntii aikasemmin kun normaalisti, nii sit oli vähän semmonen epävarma että kuuluuks mun nyt laittaa viestii vai ei. (11-104)

Ainaki toi ku tos nyt näkyy toi tommonen ”i”, nii siitä tulee itelle mieleen että ku siitä painaa nii sit sais jonku semmosen infotaulun tähän näin. (11-106)

No, niinku mä sanoin, että vähän sekava ja mä laittaisin siihen jonkun, alkuun kun sen luo, niin siihen jonkun semmosen infon. (11-108)

Ei mul muuta ku et sitä pystyis vähän niinku jokaisen omien tarpeiden mukaan ehkä enemmän modifioida, että kellä on niinku vaik ne sokerit ja kellä on sitte liikkuminen, ja et ei ois niinku, kaikki ei ois niinku samal viival vaan et sitä vois pikkasen mukauttaa

jokaisen omaan, mitä kukaki pystyy ja haluu niinku korostaa. (11-107)

No lähinnä varmaan sitä odottais et just sitä et sit tulee niinku suosituksia, et se varmaan että minkälaisii suosituksii vois olla ja kuinka henkilökohtasii ne vois olla ja kuinka nopeesti ne voi niinku sopeutuu sit siihen, myöski siihen, ehkä siihen muuttuvaan, kai se fysiologiaki täs vähän vaihtelee täs raskauden aikana et sit se voi olla varmaan haastavaa. (11-109)