

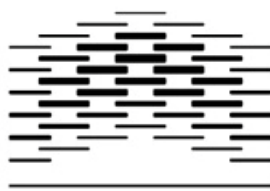
# **MASTER THESIS**

**Public health nutrition**

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## **Women's experiences of using a smartphone- application (the Pregnant+app) to manage Gestational Diabetes Mellitus - a qualitative study**

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## *Summary*

**Background:** Gestational Diabetes Mellitus (GDM), defined as glucose intolerance with first onset or recognition during pregnancy, is an increasing health challenge worldwide. A smartphone application (app) may offer new opportunities for women with GDM to manage their blood glucose values and to receive health and nutrition information. In the Pregnant+ Randomized controlled trial (RCT), a smartphone app for GDM as an addition to standard follow-up for GDM was tested and compared to standard follow up only. The app supports automatic transfer of blood glucose values from the glucometer to the smartphone and includes information about nutrition and physical activity for women with GDM. The RCT was conducted at 5 different diabetes outpatient clinics in Norway. The aim of this thesis is to explore how women who participated in the Pregnant+ RCT experienced managing GDM using a smartphone app (the Pregnant+ app).

**Methods:** Participants in the intervention group of the Pregnant+ RCT were purposely recruited. Semi-structured interviews were conducted with 17 participants. The interviews were tape-recorded and transcribed verbatim. An Interpretative Phenomenological Analysis (IPA) inspired the analytic process.

**Results:** Five main superordinate- themes were identified: Reactions to diagnosis, management of GDM, experiences with the Pregnant+app, the app's impact on women's management of GDM and their diet and the app in cooperation with health professional. The women experienced that the app increased their confidence in own GDM-management and increased their motivation for behaviour change. The information in the app was considered easily accessible and reliable. However, technological challenges and lack of support from health professionals limited the use of the app for several women.

**Conclusion:** This study has provided an insight into women's experiences and perceptions of using an app to manage GDM. The findings suggests that a smartphone app may have a great potential in assisting women with GDM in blood glucose management and increase their confidence in own GDM-management. However, it also enlightens some of the potential challenges of using mobile health technologies. The findings indicate that a closer collaboration with health professionals may be beneficial in the implementation of apps for women with GDM in the future. More studies are needed in order to further assess the use of smartphone apps for women with GDM.

## *Sammendrag*

**Bakgrunn:** Svangerskapsdiabetes, definert som glukoseintoleranse som først påvises under svangerskap, er et økende problem på verdensbasis. En smarttelefon-applikasjon (app) kan være en ny måte for kvinner med svangerskapsdiabetes til å kontrollere blodsukkerverdier og til å motta helse- og ernæringsinformasjon. I den randomiserte kontrollerte studien (RCT) Gravid+, blir en smarttelefon-app for svangerskapsdiabetes som tillegg til vanlig oppfølging testet og sammenliknet med kun standard oppfølging. Appen støtter automatisk overføring av blodsukkerverdier fra blodsukkerapparatet til telefonen og inneholder informasjon om kosthold og fysisk aktivitet for kvinner med svangerskapsdiabetes. RCTen ble gjennomført på fem forskjellige sykehus i Norge. Målet med denne studien er å undersøke hvordan kvinner som deltok i Gravid+studien opplevde å kontrollere blodsukkeret og motta helse- og ernæringsinformasjon ved hjelp av en smarttelefon-app (Gravid+appen).

**Metode:** Kvinner i intervensjonsgruppen fra Gravid+studien ble strategisk rekruttert til å være med i studien. Semi-strukturerte intervjuer ble gjennomført med 17 deltakere. Intervjuene ble tatt opp på bånd og transkribert verbatim. Analyseprosessen var inspirert av en tolkende fenomenologisk analyse (IPA).

**Resultater:** Fem hovedtemaer ble identifisert: Reaksjoner på diagnose, håndtering av svangerskapsdiabetes, opplevelser med Gravid+appen, appens påvirkning på kvinnenes håndtering av svangerskapsdiabetes og kostholdet deres og appen i samarbeid med helsepersonell. Kvinnene opplevde at appen økte selvtilliten deres i egen håndtering av svangerskapsdiabetes. Informasjonen i appen ble betraktet som pålitelig og lett tilgjengelig. Teknologiske utfordringer og mangel på støtte fra helsepersonell begrenset imidlertid bruken av appen for flere kvinner.

**Konklusjon:** Denne studien har gitt et innsyn inn i kvinners opplevelse og oppfatning av å bruke en app til å håndtere svangerskapsdiabetes. Funnene viser at en smarttelefon-app kan ha et stort potensiale i å hjelpe kvinner med svangerskapsdiabetes i å håndtere blodsukkerverdier og øke deres selvtillit i egen håndtering av svangerskapsdiabetes. Studien har også belyst noen av de potensielle utfordringene med mobil-helse-teknologier. Funnene indikerer at en tettere samarbeid med helsepersonell kan være fordelaktig i utviklingen av apper for kvinner med svangerskapsdiabetes i fremtiden. Flere studier trengs for å videre vurdere bruken av smarttelefon-apper for kvinner med svangerskapsdiabetes.

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## **List of abbreviations:**

APP: Smartphone-application

BMI: Body Mass Index

GDM: Gestational Diabetes Mellitus

GI: Glycaemic Index

IPA: Interpretative Phenomenological Analysis

OGGT: Oral Glucose Tolerance Test

mHealth: Mobile health

NSD: Norwegian Centre of Research Data

RCT: Randomized controlled trial

T2DM: Type 2 Diabetes Mellitus

WHO: World Health organization

## 1. Organisation of the thesis:

This thesis is written in an article format. It consists of two parts. In the first part the theoretical and methodological background of the study will be presented, as well as a detailed methodological discussion. This part also includes a short summary of the findings, while the results and result discussion will be presented in the second part: the article.

The article is written in accordance with the guidelines of the scientific journal *JMIR publications mhealth and uhealth*.

## 2. Introduction

Gestational Diabetes Mellitus (GDM), defined as glucose intolerance with first onset or recognition during pregnancy, is an increasing health challenge worldwide (Galtier et al, 2010). According to population-based studies, the prevalence rates of GDM vary from 1-22% (Galtier et al, 2010).

Women with GDM often have to make significant changes in their diet and lifestyle, as this can contribute to stabilize blood glucose values without medical treatment and may minimize the risk of complications (Kim, 2010; Wickstrøm et al, 2009). The regular contact with health professionals offers a great opportunity to reach women with GDM with health-and nutrition related information. In addition, earlier research has shown that pregnant women may be more receptive to health and nutrition information due to increased motivation for behaviour change (Olsen, 2005; Szwaicer, Hiddink & Koelen, 2005). Still, previous studies suggest that women have problems understanding the information about a healthy diet they receive in antenatal care (Demir, Ozsaker & Ilce, 2008; Voss, 2002; Garnweidner et al, 2013).

Furthermore, health professionals can find it challenging to communicate about nutrition and physical activity in meeting with women of different ethnic and social background (Fagerlia et al, 2005; Schouten & Meeusen, 2006). A review on women`s experiences with GDM emphasizes the need for individually tailored and culturally appropriate information for women diagnosed with GDM, and the importance of developing a GDM management routine in line with the context of the woman`s life, values and priorities (Devsam, Bogossian & Peacock, 2013).

According to World health organization (WHO) mobile health (mHealth) technologies may provide a new way to manage chronic disease and promote healthy behaviour (WHO, 2011). There is growing evidence on the positive effect of m-health interventions in the management of diabetes outside pregnancy (Liang et al, 2011; Wu et al, 2017). A recent systematic review on mobile app-based interventions to support diabetes self-management suggests that mobile-app-based interventions give a clinically significant HbA1c reduction among adult outpatients with diabetes, especially those with T2DM (Wu et al, 2017). Further, a review on telemedicine technology for diabetes in pregnancy (not limited to GDM) showed a modest, but statistically significant improvement of HbA1c associated with the use of telemedicine technology (Ming et al, 2016). More studies are needed in order to assess the use of smartphone apps in the management of GDM (Mackillop et al, 2014).

Also in Norway, the prevalence of GDM is increasing. New guidelines may reveal more cases of GDM (Norwegian Directory of Health, 2017). Current practise for women with GDM in Norway includes registering blood glucose values on paper, and to receive verbal health and nutrition information supplemented by leaflets (Borgen et al, 2017). A smartphone app can offer a new way for women to manage their condition and to receive health and nutrition information (Borgen et al, 2017). The Pregnant + study is a Randomized Controlled Trial (RCT), in which, the use of a smartphone app as an addition to standard follow-up for GDM is tested and compared to standard follow-up only at 5 different diabetes outpatient clinics in Norway (Borgen et al, 2017). 241 women are included in the study. Inclusion criteria included: 2 hour blood glucose test (OGTT)  $\geq 9$  mmol/L, access to a smartphone, understanding Norwegian, Urdu or Somali, <33 weeks pregnant and above 18 years of age. Exclusion criteria included diabetes type 1 or 2 and Lactose-and Gluten intolerance (Borgen et al, 2017).

The app supports automatic transfer of blood glucose values from the blood glucose device to the app and includes a graphic overview of blood glucose values over time. In addition, it provides tailored information about health and nutrition for women with GDM. To reach women of different cultural background the app is translated into Urdu and Somali, and it includes pictures of pregnant women of various ethnic backgrounds and food items familiar to and preferred in those cultures (Garnweidner-Holme et al, 2015). The content in the app is guided by the Health Belief Model (Garnweidner-Holme et al, 2015).



The aim of the Pregnant+ study is to find out whether the use of the Pregnant+ app can contribute to better blood glucose values for women with GDM (measured by a oral glucose test 3 months postpartum). Secondary outcomes include changes in health behaviour and knowledge about GDM, quality of life, births weight, mood of delivery and complications for the mother and child (Borgen et al, 2017).

The complexity of mHealth interventions and the different actors involved in the implementation process makes the effect of mHealth interventions hard to evaluate (Maar et al, 2017). Evaluation of the implementation process can reveal how an intervention works, how it is received by different recipients and the unanticipated effects the intervention may have (Maar et al, 2017). Qualitative studies may contribute in this evaluation by assessing the intervention and the use of these technologies from the patients' or providers' point of view (Maar et al, 2017; Pludvinski et al, 2015).

## 2.2 Aim of the study

The aim of this study is to reach a deeper understanding of the experiences of women using the Pregnant+ app to manage GDM. More specifically, the aim of this thesis was to answer the following question:

How did women with Gestational Diabetes Mellitus who participated in the Pregnant+ study experienced controlling their blood sugar and to receive health and nutrition information using a smart phone app?

To further elaborate on this, the following research questions were developed:

- 1. How did the women experience being diagnosed with GDM?*
- 2. How did the women experience using an app to manage GDM?*
- 3. In what way did the app influence the women`s management of GDM and their diet?*
- 4. How did the app function in cooperation with health professionals?*

### 3. Background

#### 3.1 Gestational Diabetes Mellitus

Gestational Diabetes Mellitus (GDM) is defined as glucose intolerance with first onset or recognition during pregnancy (Galtier et al, 2007). Risk factors for GDM includes obesity, advanced maternal age, a family history of diabetes, GDM in a previous pregnancy and adherence to certain ethnic groups (Galtier et al, 2010; Schneider et al, 2011).

In line with increasing trends of T2DM, the prevalence of GDM is increasing worldwide (Galtier, 2007). Despite the inconsistency in diagnostic criteria, studies suggest an increasing prevalence of GDM in most countries (Galtier, 2010; The Norwegian Directorate of Health, 2017). Population-based studies show prevalence rates from 1-22% (Galtier et al, 2010). The increasing prevalence of GDM may be explained by the trend towards older maternal age and the increasing prevalence of obesity among women of childbearing age (Ferrara et al, 2007; The Norwegian Directory of Health, 2017). Further, migration from ethnic groups with a higher risk of GDM may contribute to the increasing prevalence of GDM in Norway and other European countries (The Norwegian Directorate of Health, 2017).

Also in Norway, the prevalence of GDM is increasing. According to Medical Birth Registry of Norway, the prevalence is about 2-4%. (Medical Birth Registry of Norway, 2015). A cohort study from Eastern Oslo, where all women were screened for GDM, showed prevalence between 10-17% (Jenum et al, 2012). Similarly, an unpublished study from Southern Norway showed a prevalence rate of 10% (The Norwegian Directorate of Health, 2017). These findings indicate that the prevalence of GDM may be underdiagnosed in the general population. New national guidelines may uncover more cases of GDM.

GDM is associated with perinatal and long-term complications on the mother and the offspring (Galtier et al, 2010; Kim, 2010). Increased Body Mass Index (BMI) among women with GDM may partly explain some of the adverse effects of GDM (Catalano, 2010; Kim, 2010). Gestational diabetes, maternal obesity and weight gain in pregnancy are independent factors that may impact the pregnancy outcomes (Catalano, 2010). In addition, GDM, obesity and excess weight gain during pregnancy seem to have a synergic effect on adverse pregnancy outcomes (Catalano, 2010; Whiteman et al, 2015).

There is a growing recognition that early development is important in the individual's risk of later adult disease (Catalano, 2010; Kim, 2010). The intrauterine metabolic environment has an important impact on both short term and long term development of the offspring (Catalano, 2010; Kim, 2010). The well-known Barker hypothesis suggests that low birth weight is associated with hypertension, coronary heart disease and non-insulin-dependent diabetes, but also fetal overgrowth and adiposity disposes the fetus for these conditions (Catalano, 2010). GDM may dispose or programme the fetus towards excess growth, decreased insulin sensitivity and impaired insulin secretion (Catalano et al, 2003). While some studies show a higher prevalence of childhood obesity and glucose intolerance among children of women with GDM, the results are conflicting (Dabalea et al, 2007).

The increased risk for postpartum diabetes in mothers with GDM is well known (Bellamy, Casas, Higorias & Williams, 2009). Although most women recover from their glucose intolerance after birth, women with GDM have a seven-fold higher risk of developing T2DM than women without a history of GDM (Ballamy, 2009). Moreover, the increased risk of diabetes is associated with an increased risk of cardiovascular diseases, primarily for the women who develop T2DM (Carr et al, 2006; Kim, 2010). Perinatal complications associated with GDM include hypertensive disorders, preterm delivery, shoulder dystocia, stillbirth, clinical hypoglycaemia in the newborn, hyperbilirubinemia and caesarean delivery (Kim, 2010; Schneider et al, 2011).

### **3.2 Guidelines for Gestational Diabetes Mellitus in Norway**

There is growing evidence of the importance of treatment for women with GDM in order to regulate blood glucose values and reduce the risk of complications for mother and child (Campbell & Messina, 2011; Kim; 2010). During the Pregnant+ study the guidelines for diagnosis for and treatment of GDM included screening (OGTT) in gestational week 26-28 for women with an increased risk of GDM, defined as age > 38 years old, BMI > 27, previously diagnosed with GDM, diabetes in sibling or parents or immigrants from countries outside Europe with a high prevalence of GDM (The Norwegian Directory of Health, 2017). Women with a 75 g oral glucose test (OGTT)  $\geq$  9 mmol/L (2-hours plasma glucose) received specialized care at diabetes outpatient clinics. There were no standard treatment or diagnostic criteria for blood sugar values, and the follow-up for GDM varied between the different diabetes outpatient clinics. The different diabetes outpatient clinics had different treatment

criteria for fasting blood sugar and blood sugar after meals, and the women at the different clinics received different recommendations regarding how many times to measure blood sugar daily (The Norwegian Directory of Health, 2017).

The criteria for diagnosis for and treatment of Gestational Diabetes Mellitus (GDM) have been highly debated for the last years, both in Norway and internationally (Nolan, 2011; The Norwegian Directory of Health, 2017). The lack of international and national guidelines can be confusing for both women and health professionals (The Norwegian Directory of Health, 2017). Further, women with GDM rarely experience the typical diabetes symptoms like extreme thirst, frequent urination and weight loss, which makes the diagnosis harder to reveal (The Norwegian Directory of Health, 2017). New guidelines were needed in order to reveal more cases of GDM.

The new national guidelines for GDM were realised in May 2017. These recommendations include new diagnostic criteria and changes in screening and care for women with GDM. Screening for GDM (HbA<sub>2c</sub>) in the first trimester will be conducted on all women with one of the following risk factors: age >25 years, BMI >25, diabetes in pregnancy, earlier diagnosed with GDM or non-European ethnicity. The women with HbA<sub>2c</sub> >5.9 will then be followed up at diabetes outpatient-clinics, while the rest of the women continue with usual pregnancy controls until week 24-28 when they will conduct a glucose tolerance test. The new guidelines for GDM include national, standardized diagnostic criteria and treatment criteria for blood glucose values. The new diagnostic criteria define GDM as fasting blood glucose values between 5,3-6,9 mmol/l or 2-hour oral glucose tolerance test (OGGT) 9,0-11,0. Satisfactory blood glucose levels in treatment for women with GDM is defined as fasting <5,3 mmol/L and 2 hours after meal <6,7 mmol/L (The Norwegian directory of health, 2017).

### **3.3 Norwegian recommendations for diet in pregnancy**

As already mentioned, women with GDM have often have to make significant changes in their diet (Wickstrøm et al, 2009; Kim, 2010). In the recent years, there has been an increasing awareness of the impact of maternal diet on the outcome of pregnancy as well as the long-term health of mother and child (Kim, 2010; Bransæter et al, 2014). Moreover, dietary changes women make during pregnancy can often be a transition to a healthier lifestyle (Szwajer et al, 2007). Results from the Norwegian Mother and Child Cohort Study

(MoBa), indicates that maternal diet during pregnancy is likely to affect pregnancy complication, including preterm birth, preeclampsia and reduced foetal growth. The study suggests that the current dietary advice for pregnant women is likely to reduce the risk of these complications (Bransæter et al, 2014).

According to the national health authorities in Norway, pregnant women need *a balanced diet with sufficient supply of energy and all essential nutrients* (The Norwegian Directory of Health, 2017). Pregnant women are advised to follow the same nutrition recommendations as the general healthy population. These recommendations include a regular intake of fresh fruits, vegetables, whole grain and fish, and a limited intake of salt, added sugar and processed meat. In addition, pregnant women are advised to abstain from alcohol, to limit the intake of caffeine containing beverages and to reduce the intake of food containing environmental contaminants (like seagull-eggs and fish liver). Folic acid supplementation is recommended to all women who plan to become pregnant, and in the first three months of pregnancy. Pregnant women are also recommended to take a supplement of vitamin D on a daily basis (The Norwegian Directory of Health, 2017).

Women who are overweight prior to pregnancy are more likely to develop GDM. (Schneider et al, 2011). Excessive weight gain in pregnancy can lead to complications for mother and offspring, especially for women who were overweight or obese prior to pregnancy (The Norwegian Directory of Health, 2017). Nevertheless, too small weight gain during pregnancy increases the risk for low birth weight baby and related complications, as weight gain in pregnancy is positively correlated to the baby's birth weight. Pregnant women are therefore given advice on weight gain in pregnancy. In Norway, these recommendations are based on the Institute of Medicine's (IOM) published guidelines with recommendations for gestational weight gain based on the women's BMI prior to pregnancy, with the following recommendations:

Women with a pre pregnancy BMI <18.5 (underweight): 12.5-18 kilos.

Women with a pre pregnancy BMI between 18.5-24.9 (normal weight): 11.5-16 kilos.

Women with a pre pregnancy BMI between 25-29.9 (overweight): 7-11.5 kilos.

Women with a pre pregnancy BMI > 30 (obese): 5-9 kilos.

(The Norwegian Directory of Health, 2017).

### 3.4 Dietary advice for women with GDM

Dietary counselling, advice on physical activity and self-monitoring of blood glucose values is the main approach to help women with GDM to regulate their blood glucose values (Han, Middleton, Shepherd, Can & Crowther, 2017; The Norwegian Directory of Health, 2017). There is, however, an ongoing discussion about what kind of dietary advice is best for reducing the risk of health complications for mother and child (Han et al, 2017). A systematic review on dietary interventions in patients with GDM suggests that a diet with low glycaemic index (GI) was associated with less frequent insulin use and lower birth weight than control diets (Viana et al, 2014). Contradictory, a systematic review from Cochrane found no clear differences between different types of dietary advices for women with GDM (Han et al, 2017), and calls for better quality research.

Dietary advice for women with GDM in Norway are similar to those for pregnant women in general, but focus on avoiding food and drinks with high levels of sugar, choosing whole grain, eating vegetables and eating regular meals. Further, women with GDM are advised to be aware of the natural sugar content in regular milk, and the sugar content in different types of food like yoghurts and cereals (Norwegian Directory of Health, 2017). According to the new National guidelines for GDM in Norway, women with GDM should receive individualized nutrition advice based on the general nutrition guidelines for pregnant women. The dietary advice should provide sufficient amount of nutrients for mother and foetus, result in satisfactory blood glucose values (fasting  $<5.3$  Mmol/L, 2 hours after meal  $<6,7$  Mmol/L), prevent Ketonuria and contribute to adequate weight gain during pregnancy based on the woman's BMI. The guidelines emphasize the importance of giving nutrition advice based on the women's current diet, ethnicity, culture and food preferences (Norwegian Directory of Health, 2017).

### 3.5 The Health Belief Model

As already mentioned, being diagnosed with GDM implies that the women have to do changes in their diet and activity behaviors ((Kim, 2010; Schneider et al, 2011). Behavior change theories (BCT) may predict and explain whether a person is likely to change habits in benefit for his or her health (Nutbeam, Harris & Wise, 2010). The use of behaviour change theories can be beneficial in the development of smartphone-apps (Demidowich, Lu & Tamler, 2012; West et al, 2012). Previous research has found that apps based on theoretical

models like Health Belief Model are most effective (West et al, 2012).

The Health Belief Model is considered relevant for pregnant women, and has previously been used to promote physical activity among pregnant women (Pearce et al, 2012). The model consists of six constructs to predict behaviour: Perceived risk, perceived susceptibility, benefits to action, barriers to action, self-efficacy and cues to action (Nutbeam et al, 2010). According to HBM, individuals must, in order to change behaviour, be aware of their disease risk and perceive that the benefits of behaviour change outweigh potential barriers. Risk-awareness has been shown important for behaviour change (Glanz, Rimer & Wiswanath, 2008), and previous research suggest that women with GDM often lack knowledge of the risk and consequences of GDM (Carolan et al, 2010; Mills et al, 2012).

In the development of the Pregnant+ app, the following elements from the health belief model was included: perceived severity (information about the risks and consequences related to GDM), perceived benefits (information about the advantages of blood glucose control and healthy lifestyle) and cues to action (self-monitoring of blood glucose values with real-time feedback and illustrations of how to eat healthy and be physically active) (Garnweidner-Holme et al, 2015). Also during the development of the interview guide, we aimed to include questions that could help us find out if the implementation of the HBM could have contributed to behaviour-change.

### **3.6 Qualitative studies in RCTs**

RCTs are often used in health and social care to show causal relations, as their study design is the 'only one able to control for unknown or unmeasured confounders (Lewin et al, 2016). Even though randomized controlled trials are a good way to evaluate the effect of intervention, it only provides limited information about the patient experiences (Lewin et al, 2016).

Lewin (2016) outlines several ways in which qualitative studies can contribute in RCTs before, during and after a trial: Before a trial, qualitative studies can contribute by exploring issues related to the healthcare questions or the context of the research, to generate hypotheses and to develop and refine outcome measures. During a trial qualitative studies can examine if the intervention was delivered as intended, investigate the processes of implementation and

explore how the intervention was received. After a trial, qualitative studies can explore reasons for the findings, explain variations within the sample, examine the appropriateness of the underlying theory and further generate questions or hypotheses (Lewin et al, 2016).

Especially in complex health and social care interventions, the use of qualitative approaches can be useful in the evaluation process, as these involve processes that can be difficult to explore using quantitative methods only (Lewin et al, 2016). Despite to the growing recognition of the importance of qualitative assessment of clinical trials, qualitative assessments still remains uncommon, and often have methodological shortcomings (Lewin et al, 2016).

There is increasing evidence on the effect of smartphone apps in the management of chronic diseases, but little is known about the experiences of using these technologies (Pludvinski et al, 2015). Further, the complexity of mHealth intervention can make them hard to evaluate (Maar et al, 2017). Several actors are involved in the implementation process, driven by different social, cultural and environmental factors, which all have an impact on how the intervention is received (Maar et al, 2017). An evaluation of the implementation process can investigate how an intervention work, how the different actors involved receive it and the unanticipated effects that may occur. Qualitative studies can contribute in the evaluation by assessing the intervention and the use of the technology from the patient's or provider's point of view (Maar et al, 2017).

### **3.7 mHealth technologies**

mHealth is defined as *medical and public health practise supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants and other wireless devices (WHO, 2011)*. The use of mobile phones is increasing rapidly (WHO, 2011). The numbers of smartphone users worldwide is estimated to be approximately 2.1 billions in 2016 (Statista, 2016). In Norway, 81% of the adult population own a smartphone (Mediernorge, 2016). Due to the increasing use of mobile phones and the low cost of delivery, mHealth has a great potential in promoting health and in the prevention and management of disease (WHO, 2011).



mHealth is an extension of eHealth that offers new opportunities. mHealth has the potential to offer tailored information targeting different groups of people (Fiordelli, 2013). Moreover, it provides a unique opportunity to interact with people at a great frequently and in the content of the behaviour, as people tend to carry their phones with them (Fiordelli, 2013). While the Internet digital divide may have limited the potential of eHealth interventions to reach those in lower socioeconomic groups (Fiordelli, 2013; Kontos et al, 2014; Latulippe et al, 2017), the use of mobile phones have been widely adopted across socioeconomic and demographic groups (Fiordelli, 2013). As traditional health promotion methods often fail to meet disadvantaged groups, like ethnic or cultural minorities, mHealth is considered a useful tool in reaching those groups (WHO, 2011). WHO is expressing great interest in the use of mHealth to help achieve the health-related Millennium Development Goals (MDGs) in low and middle-income countries (WHO, 2011). The use of mHealth is being tested at diverse scenarios, including maternal and child health and programmes reducing the burden of disease linked to poverty (e.g. HIV/AIDS, malaria and tuberculosis) (WHO, 2011).

Patient engagement is increasingly recognized as an important part of healthcare services (Swan, 2012). Swan describes the paradigm shift in health as a shift from thinking *My health is the responsibility of my physician* to *My health is my responsibility, and I have the tools to manage it* (Swan, 2012). The importance of patient engagement in health and social services is well established in the developed world (Barello et al, 2012; Swan, 2012), and several studies suggest that it can lead to better outcomes of care (Barello et al, 2012). In their Green Paper the European Commission argues mHealth has the potential to contribute to a more patient-focused healthcare system and to support the shift towards prevention. (European Commission, 2014), mHealth and self-monitoring can help detect the development of chronic conditions at an early stage and share this information with care providers. It can also contribute to a more efficient healthcare system by reducing unnecessary consultations and to better prepare health care professionals for appointments.

Self- monitoring devices are considered to play an important role in the personalisation of health care, and have gained enthusiasm from medical and public health professionals (WHO, 2011). New technologies allow the user to monitor sleep, blood sugar, exercise and other behaviour or conditions. Digital health technologies have the potential to increase patient empowerment, as it makes the individual more involved in own health (European Commission, 2014).

### *Self-management of GDM with mHealth*

Self-management has been shown to improve glycaemic control and may reduce the risk of complications among women with GDM (Tieu et al, 2014). Self-management of blood glucose values, dietary modification and physical activity is the standard way of treating GDM (Tieu et al, 2014). New technologies may offer a new, more convenient way for patient with diabetes to manage their blood glucose values (Shan & Garg, 2015). As initially mentioned, there is increasing evidence on the use of mHealth tools to improve glycaemic control in diabetes outside pregnancy (Wu et al, 2017). More research is needed in order to assess the use of mHealth in the management of GDM.

### **3.7.2 Criticism of mHealth technologies**

As a response to the positive attention mHealth and self-monitoring have received by medical and public health literature, critical discourses of the use of mHealth are also emerging (Lupton, 2013; Sharon, 2017). Critics of mHealth claim that most research on mHealth and medical apps that have appeared in the literature have taken an instrumental approach where the focus has been on the effectiveness on behaviour change, the medical accuracy of the content and on legal and regulation issues (Lupton, 2014). On the contrary, little is known about how people use them or incorporate them into their everyday life (Lupton, 2013).

According to Lupton, these technologies involve a shift in the understanding of the body (Lupton, 2013). While people used to rely on their sensations and report to their physicians, medical technologies that produce images of the body have changed the experience and treatment of bodies. These technologies produce a virtual body that is often considered more “objective” than the signs or sensations experienced by the patient (Lupton, 2013). The fear is that people’s trust in subjective and intuitive knowledge decreases (Sharon, 2017).

Another aspect of mHealth that has received attention by critics is the increased individual responsibility for health. The use of mHealth technologies involves a shift towards directing the management of health from the state towards individual citizens (Sharon, 2017). The individual is considered a “healthy citizen” who chooses to take responsibility for their health and aims for a healthy lifestyle (Clarke, Newman, Smith, Vidler & Westmarland, 2007)

According to critics, “self-trackers” represent a particular type of individuals and may prompt an extreme form of healthism and individualism (Lupton, 2014). Moreover, when health is considered “a choice”, this can add to the burden of people for those who are ill and can not “chose health” (Sharon et al, 2017).

Critics also describe some of the potential emotional consequences of mHealth technologies. As much as self-monitoring is meant to be empowering the individual and to be a source of self-knowledge, the practise of self-monitoring may also be experienced as a burden (Lupton et al, 2013). While some people claim to feel more in control of their life and their bodies, this is not the case for all. Some users find self- monitoring too burdensome, inconvenient to use or have problems with apps that are not compatible with their smartphones. For some, self-monitoring can create an overly focus on health, and an experience of failure, anxiety and self-hatred, especially if the technologies conflicts with their own subjective experiences or suggests that their health is suffering (Lupton, 2013).

## 4. Methodology

### 4.1 Choice of methodology: Interpretative Phenomenological Analysis

An Interpretative Phenomenological Approach (IPA) inspired the research process in this study. This methodology is suitable for exploring individual's perspectives and experiences (Smith, Flowers & Larkin, 2009), and was considered appropriate for exploring the experiences of women using the Pregnant+ app to manage GDM and to receive information. IPA has previously been used to in studies exploring the experiences of women with gestational diabetes (Carolan, 2010; Evans & O'Brien, 2005).

IPA is concerned with phenomenology in its focus on individual experiences, but also have theoretical underpinnings from hermeneutics and ideography (Smith et al, 2009). The hermeneutic turn includes an interpretative view on the research data, and an understanding of the research process as an interaction between the researcher and the participants. The researcher as the primary analytic instrument is considered necessary for making sense of the experiences of the participants, rather than a source of bias to be eliminated (Fade, 2004). This view on the relationship between researcher and participants allows for acknowledging and remain aware of the active role of the researcher, and to reflect on the impact on the research process.

IPA's ideographic focus is also in line with the aims of this study in its focus on the particular. According to Smith et al (2009), the particular is essential in two ways in IPA Studies; both in the depth of analysis and in the focus on *how a particular phenomena has been understood from particular people in a particular situation* (Smith et al, 2009). As the aim of this study was to get a deeper understanding of the particular experiences of the women who participated in the Pregnant+ study and used the Pregnant+ app to manage GDM, IPA was therefore a suitable choice of methodology for this thesis also because of its ideographic focus.

### 4.2 Interviews

Individual interviews were used in the data collection. The interviews were guided by a semi-structured interview-guide, allowing change in formulations, focus and sequences of the

different questions (Smith et al, 2009). Individual interviews allows the participant to think, speak and be heard, and creates a room for conversation between the researcher and the participant (Smith et al, 2009). A qualitative interview is often described as “a conversation with a purpose” (Smith et al, 2009). The purpose is to facilitate an interaction that allows the participants to tell their own stories, related to the research question, in their own words, that will later enable us to answer the research questions through analysis (Smith et al, 2009). I conducted the interviews, usually in cooperation with one of the supervisors. The interviews lasted for about 30 minutes and were conducted at the diabetes outpatient-clinics, at health clinics or in the participant`s homes between October 2016- February 2017.

#### ***4.2.2 Development of the interview guide and pilot testing***

The research questions were the foundation for the development of the interview guide. The interview guide included questions in the following 7 categories: Experiences of diagnosis, use of the Pregnant+app, management of GDM in daily life, apps impact on diet and physical activity, diet and physical activity after birth, app in cooperation with health professionals and participating in the study (see appendix 1). The theoretical framework for the thesis also influenced the interview questions.

Throughout the development of the interview guide, the questions were discussed with two supervisors. Further, two pilot interviews were conducted by me and one of the supervisors to test how well the interview guide worked in meeting with potential participants. The women who participated in the pilot testing had both been in the intervention group of the pregnant+ study, and came from different diabetes outpatient-clinics. After the pilot interviews, more follow-up questions were added to the interview guide. Since one of the participants in the pilot study had not used the app, we also had to prepare questions in case this applied to other women as well.

#### **4.3 Selection of informants and recruitment**

As we focused exclusively on the experiences of using the Pregnant+app, we included women from the intervention group only. Purposive sampling was used to include participants from all five diabetes outpatient clinics. I recruited most participants, while one of the supervisors also contributed in the recruitment process. In addition to having been in the intervention group that had access to the app, the participants had to have completed all parts of the Pregnant+ RCT (including three questionnaires and an oral glucose tolerance test three

months after birth). Potential participants were contacted by phone, and received oral and written information about the study. Participants were recruited continuously through the research process, and recruitment continued until we perceived to have enough data to answer the research questions. Of the 23 women who were asked to participate, 6 women declined. Two women were aboard, while the rest of the women did not have time to participate. A total of 17 women were included in the study.

#### 4.4 Transcription and analysis

The interviews were tape-recorded and transcribed verbatim. Emotional expressions (like *laughing*), long pauses or other circumstances were also listed in the transcript. .

I carried out the data analysis, while potential themes and subthemes were discussed with the research team. Analysis was inspired by IPA (Fadde, 2004; Smith et al, 2009), and included the following steps: 1: Reading and re-reading, 2: initial noting, 3: developing emergent themes, 4. Searching for connections between emergent themes and cluster them into subthemes, 5: arrange the subthemes into superordinated themes related to the research questions.

##### *Step 1: Reading and re-reading:*

The first step involved reading and re-reading the original transcript. This step was conducted to ensure that the participants' experience became the focus of analysis. Slowing down and take the time for each interview was an important part of this process. Reading and re-reading helped me see the narrative in each of the participants' stories and gave me a more holistic perspective on each interview.

##### *Step 2: Initial noting:*

This step involved marking anything of interest within the transcript, and the process was started alongside with the reading and re-reading in step 1. There were no rules about what was commented about, and the aim was to produce a more comprehensive and detailed set of comment of the data that might be helpful in the following phase of identifying important themes.

##### *Step 3: Developing emergent themes:*

This step involved creating emergent themes from the initial noting in step 2. The software program NVivo (11) was used in order to identify and manage new themes. Themes were words or short phrases, sometimes directly from the transcript, and sometimes initially

interpreted by me.

**Table 1: Subthemes and themes for superordinate theme *Reactions to diagnosis***

	<b>Themes</b>
<b>Subtheme</b>	
Surprise- did not expect diagnosis	<ul style="list-style-type: none"> <li>- Did not see herself as someone at risk of getting GDM</li> <li>- Surprised</li> <li>- Shocked</li> </ul>
Expectations- expected diagnosis because of risk factors	<ul style="list-style-type: none"> <li>- Earlier diagnosed with GDM</li> <li>- Knew she was at risk</li> </ul>
Overwhelm- did not know what the diagnosis implied	<ul style="list-style-type: none"> <li>- Confused/did not know what to do</li> <li>- Didn't know what the diagnosis meant</li> <li>- Information-seeking to find out more</li> <li>- Delay in information after diagnosis</li> </ul>
Dissatisfied- the pregnancy did not turn out as expected	<ul style="list-style-type: none"> <li>- Was looking forward to enjoy food</li> <li>-Everybody thinks you can eat for two</li> <li>-Felt stupid to get diagnosed with GDM</li> </ul>
Guilt	<ul style="list-style-type: none"> <li>- Thinking about her last pregnancy</li> <li>- Thinking about the health of the baby</li> <li>- Her own fault that she got GDM</li> </ul>

*Step 4: Searching for connections between emergent themes and cluster them into sub-themes:*

This step involved collecting the themes for all participants and look for connections between these in orders to cluster them into subthemes (example of themes and subthemes: see table 1). For example the themes “hard to control blood sugar” and “constant stress” was clustered together to the theme “frustration of disease management”.

*Step 5: In the last step, the subthemes were arranged into super-ordinated themes related to the research questions:*

Originally we had a list of possible superordinate-themes related to the research questions, but

some as some of the subthemes did not fit into these themes, but was still considered as important findings, new super-ordinated themes occurred.

#### **4.5 Ethical considerations**

The Pregnant+ study was approved by NSD (Norwegian Center for Research Data). Ethical aspects are also of high relevance in the current study, as deep, individual information was gathered. The women in this study signed a written consent (appendix 2) and were informed that they could withdraw from the study at any time. Further, they were assured that the participation in the study was anonymous, and that the information would be treated with confidentiality. For example, details about the women, name of the hospitals etc. were removed.



## 5. Summary of results

This study has enlightened some of the challenges women face when diagnosed with GDM, and how an app can contribute in the process of learning to manage GDM. Five main superordinate- themes were identified: Reactions to diagnosis, management of GDM, experiences with the Pregnant+app, the app in cooperation with health professionals and the apps impact on GDM.

For most women in this study, GDM was not expected which made the diagnosis hard to accept. After the shock of diagnosis, they went through a process of learning to self-manage GDM, motivated by the health of their unborn child. Many women experienced a great amount of information from different sources, which could be confusing. They seemed to appreciate the information in the app as it provided them with an easily assessable and reliable source of information that functioned well as an extension of the information they received by health professionals.

Many women expressed that the app increased their confidence in own GDM-management. Some experienced that the self-management of blood glucose values with real-time feedback increased their motivation for behaviour change and help them achieve a feeling of control. However, the women who had trouble managing their blood glucose values, experienced more negative feelings related to the app, as the app provided them with negative feedback (sad smileys). The women who received negative feedback by mistake had the same experiences. Technological challenges limited the use of the app for several women. Some stopped using the app because the automatic transfer of blood glucose values to the app didn't work. Lack of support from health professionals was another challenge that made some women discontinue using the app.

The findings suggests that a smartphone app may have a great potential in assisting women with GDM in blood glucose management and increase their confidence in own GDM-management. However, it also enlightens some of the potential challenges of using mobile health technologies. The findings indicate that a closer collaboration with health professionals may be beneficial in the implementation of apps for women with GDM in the future. More studies are needed in order to further assess the use of smartphone apps for women with GDM.

The results will be further elaborated and discussed in the article. A detailed discussion of the methodological issues follows. .

## **6. Methodological discussion**

The aim of this thesis was to explore how women with GDM who participated in the Pregnant + RCT experienced controlling their blood sugar and to receive health and nutrition information using a smart phone app (the Pregnant + app). Qualitative approaches can provide a deeper insight to the experiences of the participants and help us understand experiences that are novel or not well understood from their point of view (Malterud, 2011). As little is known about women's experiences of using an app to manage GDM, a qualitative approach was suitable. Further, IPA was chosen to provide a deeper insight into the particular experiences of these women (Smith et al, 2009). IPA is often used to explore patient's experiences of an illness, as it is particularly useful for exploring topics that are complex and emotional (Smith et al, 2009) and was therefore well placed for the aim of this study. The interpretative nature of IPA aims for interpreting the participants' view in the light of relevant theories and earlier research, which can lead to a deeper understanding of the findings.

As mentioned, individual in depth interviews were used in the data collection for this thesis. In depth interviews are often used in IPA studies, as they are well suited to provide a deeper insight into the personal experiences of the participants (Smith et al, 2009). Using a semi-structured interview guide allowed me to engage in a conversation with the participant, where the participant was encouraged to talk about their experiences in their own words. It also allowed for follow-up on relevant topics. Focus group could be used as an alternative, but may be less suitable for assessing the individual experiences, as the group is often the focus of analysis. According to Smith et al (2009) the use of focus groups require recognition of some of the problems applying analyses to more complex social activities, which may be particularly challenging for a novice researcher (Smith et al, 2009).

### **6.2 My preconceptions**

The aim of an IPA study is not to "bracket out" the preconceptions of the researcher. However, it is important to reflect upon how the active role of the researcher may have

influenced the research process (Smith et al, 2009). My background as a public health nutritionist student and my role as a recruitment member in the Pregnant+ RCT may have had an impact on the research aims, on the development of the interview guide, on my relation with the informants and finally on the process of analysing and interpreting the results of this study. For example, the interpretative nature of IPA included personal interpreting in several parts of the analysis, for example in interpreting extracts from the transcripts into themes. According to Smith et al (2009), sensitivity to the participants is important throughout the research process, and this involves being sensitive to the background of the participants and existing literature on the topic (Smith, 2009). Having pre-knowledge on the participants may have helped me better understand the participants and access sensitivity to the topic. The fact that I was well known with the treatment and follow-up for women with GDM could be a benefit during the interviews. According to Dahlgren et al (2004), pre-knowledge on the topic of study can help identify follow-up questions during an interview (Dahlgren et al, 2004). Still, it is important to remain open to the participants' experience. The semi-structured interview guide allowed me to let the participants tell their own stories. I avoided leading questions and tried to focus on the participants' experiences. Further, the research process was discussed with two supervisors, which could increase the trustworthiness of the findings.

### **6.3 The participants**

As the aim of this study was to focus exclusively on the use of the Pregnant+ app. Therefore, we only included women from the intervention group. However, including women from both the intervention group and the control group could help us explore the differences between managing GDM with or without a smartphone app. Moreover, the women who participated in this qualitative study have agreed to participate in both the Pregnant+ RCT and the current study. These women may represent a group of women with an interest in research or nutrition. Still, most of the women that were contacted were positive towards participating in the study. Of the 23 women who were asked to participate in the study, 17 women agreed to participate.

Given the complexity of most human phenomena, IPA studies normally operate with small sample sizes, but there is no right answer to the question of sample size in IPA studies (Smith et al, 2009). To assess whether we gathered enough data to answer the research questions, the interviews were analysed continuously, and data gathering continued until we perceived to have enough data to answer the research questions.

Initially, the plan was to include women who used the app in Norwegian, Urdu and Somali. As there were few potential participants with at the time of the data sampling (n=3), and these women were hard to reach, we did not get the chance to include women who used the app in other languages than Norwegian. Although one participant in the current study had Urdu as native language, she preferred to use the app in Norwegian. The fact that most women included in the study spoke Norwegian fluently could have increased the quality of the study, as language barriers or the use of an interpreter may lead to methodological challenges (Squires, 2009). One participant (pilot) spoke poorly Norwegian, and this woman did not download or use the app. However more efforts could have been made to recruit informants using the app in Somali and Urdu. This will be particular relevant for the further development of the Gravid+app. Another limitation in this study is the time passed between birth and interview, which could have made it hard for the women to remember their use of the Pregnant+ app.

#### 6.4 Validity and quality

There is a considerable discussion among qualitative researcher regarding the assessment of quality in qualitative research (Smith et al, 2009). Many qualitative researchers are dissatisfied with the fact that qualitative research is being assessed according to validity and reliability that are applied to quantitative research (Smith et al, 2009). As a result, a number of methods for assessing qualitative research have emerged (Smith et al, 2009). Smith et al (2009) argue that some of these methods can be too simplistic and may ignore some of the subtle features of qualitative work, but identify Yardley's criteria as a suitable approach to assess the quality of IPA studies due to its broad approach (Smith et al, 2009). Yardley's criteria present the following four principles for assessing the quality of qualitative studies: *Sensitivity to context, commitment and rigour, transparency and coherence* and *impact and importance* (Smith et al, 2009).

*Sensitivity to context* includes showing awareness to the data, the context of the situation and the interactive nature of the data collection throughout the research process (Smith et al, 2009). Yardley's criteria suggest several ways to address sensitivity to context in an IPA study. This involves showing sensitivity to the socio-cultural milieu, the existing literature on the topic and the material obtained from the participants (Smith et al, 2009). To make sure the

participants voice is heard, it is important to show awareness to the participants during the interviews. This requires a close awareness of the interview process in order to show empathy and putting the participants at ease (Smith et al, 2009). During the interviews, we always started with simple questions about the participants and the baby in order to make the participant feel comfortable. In the results, extracts from the transcripts were included. This gave the participants a voice in the project, while it allows the readers an insight into the interpretation that was made in the analytic process.

*Commitment* involves attentiveness to the participants during data collection and the care in which the analysis is carried out (Smith et al, 2009). *Rigour* refers to the thoroughness of the study. This includes the appropriateness of the sample to the current question, the quality of the interviews and the completeness of the analysis (Smith et al, 2009). The participants were carefully chosen to answer the aim of this thesis. According to Smith et al (2009) a good IPA interview requires skills, awareness and dedication. This can be demanding for researcher new to IPA, and training and supervision is therefore important in (Smith et al, 2009). In order to achieve good quality interviews, the interviews were usually conducted in cooperation with one of the supervisors. After conducting several interviews with a supervisor, I conducted some interviews on my own. The analytical process was also discussed with the supervisors in order to improve the quality of the analysis and to assess *commitment and rigour*.

The third criteria, *Transparency and coherence*, refers to how well the research process is described in the study and how the themes hang together logically. In my thesis, I have attempted to provide the reader with detailed information about the research process, including how my own role may have influenced the process. I included extracts from the transcripts and the analysis, a detailed description of the interview guide and information about how I conducted the analysis step by step. As there is no standard analytical process in qualitative research, a description of the analysis is particularly important (Smith et al, 2009). While the aim of qualitative studies is not to generalise, qualitative studies can be transferable to similar groups in similar contexts (Malterud, 2011). A description of the sample, the setting and the process of the study are also important in order to assess to which extent the findings can be transferable to a similar group in a similar setting (Smith et al, 2009). A thick description can enable readers to evaluate its transferability to similar groups or contexts (Smith et al, 2009). Detailed background information on the participants is therefore also

presented in the findings. Still, information about social background, material status, age and occupation could have provided a better image on the participants.

The final principle of Yardley's criteria is *impact and importance* and is about whether the research conducted tells the reader something interesting, important or useful (Smith et al, 2009). This thesis has provided a new insight into a topic there is little knowledge about: women's use of an app to manage GDM. It has also enlightened some of the aspects that can be relevant in the development of smartphone apps for this group of women in the future.

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## 7. The article

### **Title: Women's experiences of using a smartphone- application (the Pregnant+app) to manage Gestational Diabetes Mellitus - a qualitative study**

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### **Abstract**

**Background:** Gestational Diabetes Mellitus (GDM), defined as glucose intolerance with first onset or recognition during pregnancy, is an increasing health challenge worldwide. A smartphone application (app) may offer a new way for women with GDM to manage their blood glucose values and to receive health and nutrition information. The Pregnant+ Randomized controlled trial (RCT), a smartphone app for GDM as an addition to standard follow-up for GDM was tested and compared to standard follow up only. The app supports automatic transfer of blood glucose values from the glucometer to the smartphone and includes information about nutrition and physical activity for women with GDM. The RCT was conducted at 5 different diabetes outpatient clinics in Norway.

**Objective:** The objective of this study is to explore how women who participated in the Pregnant+ RCT experienced controlling their blood glucose values with the Pregnant+ app and to receive health and nutrition information using a smartphone app (The Pregnant+ app).

**Methods:** Participants in the intervention group of the Pregnant+ RCT were purposely recruited. Semi-structured interviews were conducted with 17 participants. The interviews were tape-recorded and transcribed verbatim. An Interpretative Phenomenological Analysis (IPA) inspired the analytic process.

**Results:** Five main superordinate- themes were identified: Reactions to diagnosis, management of GDM, experiences with the Pregnant+app, the app's impact on women's management of GDM and their diet and the app in cooperation with health professional. The women experienced that the app increased their confidence in own GDM-management and increased their motivation for behaviour change. The information in the app was considered easily accessible and reliable. However, technological challenges and lack of support from health professionals limited several women from using the app.

**Conclusion:** The findings suggest that a smartphone app may have a great potential in assisting women with GDM in blood glucose management and increase their confidence in own GDM-management. However, it also enlightens some of the potential challenges of using mHealth technologies. The findings indicate that a closer collaboration with health professionals may be beneficial in the implementation of apps for women with GDM in the future. More studies are needed in order to further assess the use of smartphone apps for women with GDM.

## Introduction

Gestational Diabetes Mellitus (GDM), defined as glucose intolerance with first onset or recognition during pregnancy, is an increasing health challenge worldwide [1]. According to population-based studies, the prevalence rates of GDM vary from 1-22% [1]. The great variety in prevalence rates may be attributable to differences in screening and diagnostic criteria as well as heterogenic study populations [1, 2]. Risk factors for developing GDM include obesity, advanced maternal age, a family history of diabetes, GDM in a previous pregnancy and adherence to certain ethnic groups [1,3,4]

Although the blood glucose values after birth stabilize for most women, both women and their offspring have an increased risk of developing diabetes type 2 (T2DM) later in life [1,5], GDM is associated with perinatal and long-term complications on the mother and the offspring [1,5]. Women with GDM often have to make significant changes in their diet and lifestyle, as this can contribute to stabilize blood glucose values without medical treatment and may minimize the risk of complications [5,6]

Earlier research has shown that pregnant women may be more receptive to health and nutrition information due to increased motivation for behavioural change [7,8]. The regular contact with health professionals during antenatal care offers a great opportunity to reach women with GDM with health- and nutrition related information. However, previous studies suggest that women have problems understanding the information they receive about a healthy diet in antenatal care [9,10,11]. Furthermore, health professionals can find it challenging to communicate about nutrition and physical activity in meeting with women of different ethnic and social background [12,13]. A review on women's experiences with GDM emphasizes the need for individually tailored and culturally appropriate information for women diagnosed with GDM, and the importance of developing a GDM management routine

in line with the context of the woman's life, values and priorities [14]. A smartphone app can offer a new way for women to manage their condition and to receive health and nutrition information [15].

The use of Mobile health (mhealth) technologies provides a new way to manage chronic disease and promote healthy behaviour [16]. There is growing evidence on the effect of m-health interventions in the management of diabetes outside pregnancy [17,18]. A recent systematic review on mobile app-based interventions to support diabetes self-management suggests that mobile-app-based interventions give a clinically significant HbA1c reduction among adult outpatients with diabetes, especially those with T2DM [18]. Further, a review on telemedicine technology for diabetes in pregnancy (not limited to GDM) showed a modest, but statistically significant improvement of HbA1c associated with the use of telemedicine technology [19]). More studies are needed in order to assess the use of smartphone apps in the management of GDM [19,20]. The complexity of mHealth interventions and the different actors involved in the implementation process makes the effect of mHealth interventions hard to evaluate [21]. Evaluation of the implementation process can reveal how an intervention works, how it is received by different recipients and the unanticipated effects the intervention may have [21]. Qualitative studies may contribute in this evaluation by assessing the intervention and the use of these technologies from the patients' or provider's point of view [21,22].

#### *The Pregnant+ study*

Current practise for women with GDM in Norway includes registering blood glucose values on paper, and to receive verbal health and nutrition information supplemented by leaflets [15]. In the Pregnant+ RCT, the use of a smartphone app as an addition to standard follow-up for GDM is tested and compared to standard follow-up at 5 different diabetes outpatient clinics in Norway [15]. 241 women are included in the study. The smartphone supports automatic transfer of blood glucose values from the blood glucose device to the app and includes a graphic overview of blood glucose values over time. In addition, it provides tailored information about health and nutrition for women with GDM in Norwegian, Urdu and Somali [23]. The aim of the study is to find out whether the use of the Pregnant+ app can contribute to better blood glucose values for women with GDM (measured by a oral glucose test 3 months postpartum)[15].



### **Aim of the study**

This qualitative study describes the experiences of participants in the Pregnant+ study of using a smartphone app (The Pregnant+ app) to manage GDM. The aim of this study is to explore how participants with GDM experienced controlling their blood glucose values and to receive health and nutrition information using the Pregnant+ app. This study can give an insight in the experiences of using an app to manage GDM. This can provide a better understanding of the findings from the RCT, and identify aspects that can be important in the development and implementation of smartphone apps for women with GDM in the future.

### **Methods**

An Interpretative Phenomenological Approach (IPA) inspired the research process in this study. This methodology is suitable for exploring individual's perspectives and experiences [24], and was therefore considered appropriate for exploring the experiences of women using the Pregnant+ app to manage GDM. IPA has previously been used to explore the experiences of women with gestational diabetes [25,26].

### **Interviews**

Semi-structured interviews were used for data collection. The first author (JBS) conducted the interviews, usually in cooperation with the second author (LGH). Two pilot interviews were conducted to see how well the interview guide worked in meeting with potential participants. The interviews lasted for about 30 minutes and were conducted at the diabetes outpatient-clinics, at health clinics or in the participant's homes between October 2016- February 2017.

### **Selection of informants and recruitment**

As we focussed exclusively on the experiences of using the Pregnant+app, we included women from the intervention group only. Purposive sampling was used to select participants from all five diabetes outpatient clinics. In addition to having been in the intervention group that had access to the app, the participants had to have completed all parts of the Pregnant+ RCT (including three questionnaires and an oral glucose tolerance test three months after birth). Potential participants were contacted by phone, and received oral and written information about the study. Participants were recruited continuously through the research process, and recruitment continued until we perceived to have enough data to answer the

research questions. Of the 22 women who were asked to participate, 6 women declined. Two women were aboard, while the rest of the women did not have time to participate. A total of 17 women were included in the study.

### Analysis

The interviews were tape-recorded and transcribed verbatim. The first author carried out the data analysis, while potential themes and subthemes were discussed with the research team. The software program NVivo (11) was used in order to identify and manage new themes. Analysis was guided by IPA [24, 27] and included the following steps: 1. Reading and re-reading, 2. Initial noting. 3. Developing emergent themes, 4. Searching for connections between emergent themes and cluster them into sub-themes. 5. Arrange the sub-themes into super-ordinate themes related to the research questions.

### Results

#### Characteristics of study participants and their use of the Pregnant+ app

We recruited women from all five diabetes outpatient clinics in which the Pregnant+ study was conducted. The participants were either ethnic Norwegian (n=10) or came from the following European and Asian countries (n=7): Poland, Bulgaria, Turkey, Pakistan, Palestine and Sweden. All women who used the app used it in Norwegian. Two women were previously diagnosed with GDM. Some women used the app daily for blood glucose management (n=10), some used it for information only (n=5) and two women did not download the app, even though they were allocated in the RCT to using it. Table 1 describes characteristics of the participants and their use of the app.

**Table 2: Characteristic of the participants and their use of the app**

	Ethnicity	Earlier diagnosed with GDM	Diabetes outpatient clinic	Months passed between birth and interview	Use of the Pregnant+ app
<b>Participant</b>					
1	Immigrant background	No	1	4	No
2	Ethnic Norwegian	No	2	9	Daily
3	Ethnic Norwegian	Yes	3	6,5	For information
4	Ethnic	No	2	7	Daily

	Norwegian				
5	Immigrant background	No	4	7	Daily
6	Ethnic Norwegian	No	5	8	For information
7	Immigrant background	No	5	4	Daily
8	Immigrant background	No	2	6,5	No
9	Immigrant background	Yes	2	4	For information
10	Ethnic Norwegian	No	2	4	Daily
11	Ethnic Norwegian	No	1	10	For information
12	Immigrant background	No	4	4	Daily
13	Ethnic Norwegian	No	4	4	For information
14	Immigrant background	No	1	9	Daily
15	Ethnic Norwegian	No	3	8	Daily
16	Ethnic Norwegian	No	1	3	Daily
17	Ethnic Norwegian	no	3	7	Daily

## Findings

Five main themes (superordinate- themes) related to the research questions were identified.

**Table 3: Superordinate themes and sub-themes**

	Sub-themes
Super-ordinate themes	
<b>1. Reactions to diagnosis</b>	<p>Surprise – did not expect diagnosis</p> <p>Expectation- expected diagnosis because of risk factors</p> <p>Overwhelm- did not know what the diagnosis implied</p> <p>Disappointment- the pregnancy did not turn out as expected</p> <p>Guilt- thinking of the baby</p>
<b>2. Management of GDM</b>	Learning to self-manage GDM

	<p>Social support</p> <p>Nutrition-related advice from social surroundings</p> <p>Frustration</p> <p>Making priorities</p> <p>Loss of motivation after birth</p> <p>Positive impact on pregnancy</p>
<p><b>3. Experiences of using the Pregnant+ app</b></p>	<p>Perceived that the app provided easily accessible information</p> <p>Perceived that the app provided trustworthy information</p> <p>Perceived that the overview of blood glucose increased feeling of control</p> <p>Wanted more information, in particular about GDM related risks</p> <p>Technological challenges</p> <p>Frustration when the app provided negative feedback or feedback conflicting with hospital advice</p>
<p><b>4. The Apps impact on women`s management of GDM and their diet</b></p>	<p>Increased confidence in own GDM-management</p> <p>Feeling of control</p> <p>Increased motivation to manage blood-glucose values/towards healthy eating</p> <p>Increased self-awareness about blood glucose-management</p> <p>Frustration/obsession</p>
<p><b>5. The App in cooperation with health professionals</b></p>	<p>Perceived that health professionals had little knowledge of the app</p> <p>Health professionals showed little interest in the app</p> <p>The app could function as a supplement to meetings with health professionals</p>

### *Reaction to diagnosis*

The women in this qualitative study had various reactions to receiving the GDM diagnosis. Most women expressed disappointment or sadness when asked about how they reacted when they received the diagnosis. Some women were better prepared for the diagnosis because of personally perceived risk factors like being overweight, their ethnic background, age, having diabetes in their family or having diabetes in a previous pregnancy. The diagnosis was harder to accept for those who did not perceive themselves as being at risk for developing GDM:

*I know many people with diabetes, and I must say I was shocked... I think that has something to do with my lifestyle and my weight and my health. I didn't considered myself at risk of getting it (GDM).*

(P12)

Feeling overwhelmed was an emerging subtheme throughout the interviews. Most women did not know what the diagnosis implied, and there was a lot of information to process. Some also pointed to the delay of information after they received the diagnosis. These women received the diagnosis over the phone, and had to wait some time before they got an appointment at the diabetes outpatient clinic. This led to insecurity, as illustrated by the following statement:

*Like... What am I going to do? And then there was the visit at the hospital, but like, before I got there, like: Should I not eat anything?*

(P11)

As mentioned, many women were disappointed that they got GDM. Some because they, again, did not consider themselves the *typical GDM patient*, others because receiving the diagnosis implied that their pregnancy did not turn out as they expected. These women considered pregnancy as a time where they did not have to worry about healthy eating or dieting, while the diagnosis often meant they had to follow a very strict eating regime:

*It was a bit disappointing to receive the diagnosis, because I was looking forward to a freer life where I could treat myself a little more.*

(P7)

Furthermore, some women blamed themselves for getting GDM and expressed guilt as a reaction to the diagnosis. The feelings of guilt was especially evident in the two women who feared they might have had undiscovered GDM in a previous pregnancy.

### *Management of GDM*

Managing GDM, for most women, was a process of learning how to self-manage the condition. This included testing how to measure blood glucose values and to adjust their diet

and physical activity in order to regulate blood glucose values:

*I tried different things and found out what I could eat and what I could not eat*

(P16)

Over time, most women claimed to have “found the balance,” and learned what to eat in order to keep their blood glucose values down. Most women were in charge of cooking dinner for their family, and found new ways so that the family could still eat together. Many women ate the same as the rest of the family, but helped themselves with less rice, pasta etc. in replace of more vegetables, like this woman said:

*I just had to be aware of what I put on my plate.*

(P8)

In regards to social support to manage GDM and change dietary habits, the women had different experiences. Most women found great support in their partner, while one woman experienced that her partner did not see the severity of the situation. Adhering to their new eating habits was commonly easier at home than in social settings surrounded by other family members or friends:

*I struggled a bit when I visited mom (....) Home I could just take... I had my system there. But she had cakes and...*

(P14)

Several women experienced a large amount of nutrition-related information from those around them. Most of them tended to consider this information with scepticism:

*There are so many hypes around... You must not tell anybody that you have GDM, because you will get so many advices.*

(P2)

Throughout the interviews, it was clear that most women experienced managing blood glucose values as a source of stress. They expressed great concern about evaluating blood glucose values:

*You think about the blood sugar values all the time, and if they increase, you get stressed.*

(P9)

There were, however, differences between the women regarding how strict they needed to be in order to regulate their blood glucose values. While some women only had to limit their intake of sugar, others struggled to keep their blood glucose low despite eating a very low

amount of carbohydrates. For these women the dietary advices in the app were often not strict enough, and they expressed more negative feelings related to the management of GDM.

Most women perceived the health of the baby as more important than their own risk of developing T2DM. During the pregnancy, women described themselves as highly motivated to eat healthy, but this seemed to change after birth. Loss of motivation to eat healthy after birth was a common subtheme throughout the interviews. Many women expressed feelings of freedom after the baby was born:

*Once I had the freedom and no longer had the baby's health in my hands in the same way, it was easier to give in if I wanted to eat something.*

(P17)

Still, many women expressed that having to cope with GDM had a positive impact on their diet and weight management in pregnancy, as they were “forced” to eat healthy:

*It was good for me, in a way, because you are forced to eat healthy.*

(P3)

#### *Experiences of using the Pregnant+app-*

The women had different experiences with the app, and used the app in different degree, (Table 1). Some used it daily for blood glucose management, some only used it for information while two women did not use the app. Regarding the information in the app, however, most women who used the app seemed to find it easily accessible, as illustrated by the following statement:

*You have the freedom to lie on your bed in the middle of the night and register, (blood glucose levels) read more and scroll back.*

(P7)

Many also pointed out the benefits of having all the information in one place.

Furthermore, women perceived the app as a reliable source of information, and consistent with the information provide by health professionals. However, many women wanted more information in the app. The information in the app was often perceived as “too simple,” as this woman said:

*Some of the dietary advices was a little too obvious- like soft drinks, I know I shouldn't be drinking that.*

(P4)

Some women also missed having more risk-awareness related information to the possible effect on the baby, which they claimed to be the best motivation for eating healthy during pregnancy.

The overview of the blood glucose values and the real-time feedback from the app, were by many women perceived as the most important part of the app. Most women liked getting an overview on the blood glucose values over time, while many found the real-time feedback from the app motivating. However, women seemed to experience frustration when the feedback from the app conflicted with blood-glucose limits provided by their health professionals:

*It gave me an angry smiley before the diabetes doctor did, and then you get a bit frightened. I think that was irritating.*

(P15)

The negative feelings related to the app, also seemed to apply to the women who had trouble managing their blood glucose values. None of the three women who eventually had to use insulin used the app to manage their blood glucose values, and they seemed to experience the app as a burden:

*I don't need another place where I can read what I should not eat*

(P11)

Moreover, many women experienced technological problems in using the app. Several had problems with the automatic transfer of the blood glucose values to the app, and many stopped using the app to register blood glucose values because of this:

*It was supposed to transfer the blood glucose values automatically to my phone, but it never worked. I think that was a big disadvantage, because eventually I didn't bother to write it manually in the app*

(P6)

Some women chose to register their blood glucose values manually in the app. This could also be a challenge as the app did not allowed the women to separate between *fasting* and *after meal*, which sometimes led to wrong feedback from the app:

*When I was trying to register a good blood glucose value, and then it turns out bad because you've typed something wrong, and you can't change it. It just kills me.*



(P13)

A few women, however, tend to do their best to make the app work despite meeting technological challenges. This included calling project member, searching for information about the blood glucose device online, or continuing registering their blood glucose values manually in the app. These women described themselves as highly motivated to use the app, and seemed to consider the app a very helpful tool in their management of GDM.

*Suggestions for improvement*

Some of the women had suggestions for improvement for the app. This included the possibility to take notes when registering blood glucose values, changes in layout, more interactivity and pop-up messages and a better user-manual.

*App's impact on women's management of GDM and their diet*

Analysis of the transcripts indicated that the app had an impact on the women's management of GDM and their diet in several ways. The app seemed to increase the confidence in GDM-management for some women, and several women reported that they were pleased with their own management of GDM:

*Both the app and the help I've gotten at the hospital helped me to succeed as well as I did in the pregnancy, and I'm very happy with that.*

(P17)

Furthermore, some women reported that the app gave them a feeling of control:

*I felt that to register in the app was very important... In that way the app was very important, because it gave me a feeling of control.*

(P2)

The real-time feedback seemed to function as a motivation to eat healthy and engage in physical activity for some women, as they aimed for positive feedback. A few women, however, admitted that they sometimes "cheated" in order to get better values and feedback: *Sometimes I waited ten minutes so it would be lower (blood glucose values), because you kind of wanted to proof something.*

(P14)

It also seemed that the app contributed in increasing self-awareness for some women. The

overview of the blood glucose values helped them see how well they were managing their blood glucose values over time, while the real-time feedback could function as an instant source of self-awareness. Furthermore, the information in the app might also have had an impact on increasing self-awareness, as it could increase women's knowledge about GDM. Also after birth, some women reported taking choices that are more conscious because of increased knowledge:

*I'm no longer as strict as I was in the pregnancy, but I've learnt a lot and make more conscious choices.*

(P4)

A few women however, expressed that the feedback and the overview on the blood glucose values made them obsessed. These women tended to measure the blood glucose values more often than recommended, and spent a lot of time using the app:

*My husband said: That can't be good for you. You use it all the time. So I strived very much for it to be normal.*

(P7)

These women did, however, seem to successfully achieve control over their blood glucose values. Despite being obsessed with the app in the beginning, they seemed to have positive experiences with using the app.

### **The app in cooperation with health professionals**

Women reported differences in how health professionals related to the app, depending on where they received health care. Most women's overall impression, however, seemed to be that health professionals had little knowledge about the app, and that they were not able to help them when they had problems with the app:

*I don't think they knew much... When I couldn't make it work, they just gave me a phone number, but I ended up going online and learn the blood glucose measurement by myself and how to do everything.*

(P12)

Many women also reported that the health professionals seemed to have little interest in the app, and that they seemed more comfortable with looking at the blood glucose values on paper. Some women stopped using the app to register blood glucose values because the health professionals only looked at their book:

*Because I had no interest in writing it two places, and I understood that no one was going to*

*read or use my app... They always asked for my book, so I used that.*

*(P11)*

All the women who read the information in the app confirmed that the dietary advice and the information about GDM in the app were consistent with the information they received at the hospital (except from blood glucose limit-values in some cases). There seemed to be a common understanding among most women that the information in the app could function as a supplement and a reminder of the information they received at the diabetes outpatient clinics.

## **Discussion**

The aim of this study was to explore how women with GDM who participated in the pregnant+ RCT experienced controlling their blood glucose values and to receive health and nutrition information using the Pregnant+ app. The study has enlightened some of the challenges women face when diagnosed with GDM, and how an app can contribute in the process of learning to self-manage GDM. The health of the baby seemed to function as a strong motivator for blood glucose management throughout the pregnancy. The information in the app was considered trustworthy and seemed to function well as an extension of the information provided by health professional. Self-management of blood glucose values with real time feedback was for many women perceived a useful tool in their management of GDM that could lead to a feeling of control. However, the women who had trouble managing their blood glucose values, experienced more negative feelings related to the app, as the app provided them with negative feedback. Challenges like technological problems and lack of support from health professionals seemed to affect the women's use of the app in a negative way.

Some of the participants in this study had negative feelings followed by diagnosis of GDM, which were also seen in other qualitative studies on women with GDM [14, 25]. While pregnancy is often associated with certain expectations, developing GDM often implies that the pregnancy does not turn out as expected [25]. For most women, the diagnosis was not expected. Similar to what found in other studies on pregnant women [11,14], most women had little knowledge about the risk and consequences of GDM. An interpretative review on women`s experiences with GDM revealed that the lack of information followed by diagnosis

contributed to feelings of uncertainty and vulnerability, as the women did not fully understand the impact of the GDM diagnosis [14]. This is consistent with the findings from the current study.

Pregnant women often seek nutrition information, especially after being diagnosed with GDM [11,28]. Previous studies have found that pregnant women navigate between three different sources of information: health professionals, Internet and their social surroundings [7, 11, 26]. While health professionals are considered the most reliable source of information, Internet is often the most frequently used [11]. Also in our study, women considered health professionals as the best source of information. Some women pointed out that the limited time of the consultations could make the information hard to process, which may explain the need for excess information among the women in this study.

The process of learning to manage GDM is described in several studies on women with GDM [25,26,]. Carolan et al (2012) described the process of learning to manage GDM as a demanding and challenging process [26]. During this process women have to learn how to measure their blood sugar and adjust their diet and physical activity in order to manage their blood glucose values. This process was strongly facilitated by social support, while the health of the baby served as the main motivation throughout the process [26]. The women in this study expressed similar experiences. Previous studies on women with GDM, suggest that the baby's health as a motivation might do women with GDM more receptive towards interventions to manage their condition [14,26]. GDM is also described as having a positive impact on women's life, as they adopt new healthier lifestyle habits [25]. Although many women in this study claimed that having GDM had a positive impact on their diet and weight-management during pregnancy, most women had returned to their earlier diet habits after birth. A study on women with history of GDM found that while women understand the association between GDM and 2TDM, they often don't perceive themselves at risk [29], which seemed to apply to the women in our study.

Most women seemed to appreciate the Pregnant+ app as an extension of the information provided by health professionals. Similarly, a pilot test of an app to monitor gestational weight gain found that an app could help pregnant women to cope with the great amount of information provided by different sources [30]. However, there were individual differences regarding how women in our study perceived the information in the app. Some women

perceived that the information in the app was too easy, while others could not use the dietary advice in the app, as they needed a lower amount of carbohydrates in order to regulate their blood glucose values. This may highlight the need for more tailored information. Individually tailored information is important to promote behavioural change, as individuals are more likely to change behaviour if they perceive the information as personal relevant [31]. mHealth has a great potential in offering tailored information targeting different groups of people [32]. Although the app was tailored in order to meet the needs for women of different cultural backgrounds [23], the findings from this study suggest that other individual differences should also be taken into consideration. The fact that all women in the current study, except one, spoke fluently Norwegian and had resided in Norway for several years may contribute to the lack of differences between the women with immigrant background and the women who were ethnical Norwegian.

Not surprisingly, as the Pregnant+app is newly developed, most women experienced some technological challenges when using the app. While most women were positive to the idea of using an app in the management of GDM, they were sometimes discouraged when faced with technological challenges, especially regarding the automatic transfer of blood glucose values to the smartphone. A cross-sectorial survey on mHealth for diabetes among Latino patients found that the lack of operability between the smartphone app and other devices could serve as a barrier towards using the app [33]. In the same study, the perceived lack of additional benefits was also considered an important barrier towards using mHealth technologies for diabetes management [33]. In the current study, many women did no longer seem to see the benefits of using the app to manage GDM when the automatic transfer of the blood glucose values didn't work.

Self-management of blood glucose values, including overview on blood glucose values and real-time feedback, were by many experienced as the most important part of the app to increase self-awareness and motivation to manage GDM. These elements of the app trigger concrete behaviour responses and serve as a *cue to action*, according to the Health Belief Model. This model suggests that in order to change behaviour; individuals must perceive that the benefits of the behaviour outweigh potential barriers [34]. Previous studies suggest that the use of Behaviour Change Theories (BCT) can be beneficial in the development of smartphone apps [35,36]. In the development of the Pregnant+app, elements from the Health Belief model were applied. While traditional public health intervention often focus on

educating the patients to improve healthy behaviour, studies on mHealth interventions suggests that behaviour triggers may have a big role in the apps impact on behaviour change [22,37]. A qualitative study on a smartphone app for T2DM also suggests that feedback serve as a motivation for behaviour change [22].

A small group of women described themselves as “obsessed” with their own blood sugar values, and tended to measure their blood sugar more frequently than recommended. These women seemed to represent a group who particularly appreciated self-monitoring as a way of achieving control over their GDM-management. Critics of mHealth technologies have argue that “self-trackers” represent a particular group of people, and that mHealth technologies may prompt an extreme form of *healthism* and individualism [38]. Further, critics of mHealth emphasize that while smartphone apps can lead to a feeling of control, the opposite effect occurs if the data produced by these technologies suggests that their health is suffering or conflicts with their the participant’s own interpretation of their health [38]. This seems to apply to the current study, as women experienced displeasure when the app gave them wrong feedback or showed increased blood glucose values, while the women who did not succeed in managing their blood glucose values stopped using the app to manage their blood glucose values. Another qualitative study on the opportunities and challenges for smartphone apps also found that patients could be demotivated and might discontinue using apps when the app showed that they did not succeed in meeting a goal or provided them with negative feedbacks [39]. More qualitative studies are needed in order to evaluate the potential emotional consequences of mHealth technologies.

Many women in this study experienced lack of support from health professionals in the use of the Pregnant + app. A study on smartphone apps for T2DM suggests that a smartphone app for diabetes was most successful when optimally coordinated with personalized health coaching [22]. However, health professionals involved in the Pregnant+ study were asked to provide participants of the intervention and the control group with standardized care, without specific focus on the app. A closer collaboration with health professional in the implementation of the app might have increased the benefits of the app for the women who used it, and make more women benefit from the app for the women in the current study.

### Limitations

Women who participated in this qualitative study have agreed to participate in both the Pregnant+ RCT and this qualitative study, and may represent a self-selected group of women. We did not get a chance to include women who used the app in Urdu or Somali. This would have been a particular relevant group to include in order knowing more about specific challenges in dealing with the app. The research design only included women from the intervention group. To include women from both groups would have allowed us to explore the differences between managing GDM with or without a smartphone app. Another limitation in this study is the time passed between birth and interview, which could have made it hard for the women to remember their use of the Pregnant+ app.

### Conclusion

This study has provided an insight into women's experiences and perceptions of using an app to manage GDM. The findings suggest that a smartphone app may have a great potential in assisting women with GDM in blood glucose management and increase their confidence in own GDM-management. However, it also enlightens some of the potential challenges of using mHealth technologies. The findings indicate that a closer collaboration with health professionals may be beneficial in the implementation of apps for women with GDM in the future. More studies are needed in order to further assess the use of smartphone apps for women with GDM.

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## Appendix 1: Interview guide

<p><b>Svangerskapsdiabetes:</b></p> <ul style="list-style-type: none"> <li>- Hvordan går det med dere? Hvor gammel er barnet nå?</li> <li>- Hvordan var det å ha bli fortalt at du hadde svangerskapsdiabetes?</li> <li>- Var det første gang at du hadde svangerskapsdiabetes? (oppfølgingsspørsmål hvis ikke)</li> <li>- Kjenner du noen andre som har svangerskapsdiabetes?</li> <li>- Hvordan tror du det å ha svangerskapsdiabetes har påvirket ditt svangerskap?</li> </ul>	<p><b>Bruk av appen:</b></p> <ul style="list-style-type: none"> <li>- Pleier du å bruke apper? (hvilke? Relatert til helse?)</li> <li>- Kan du fortelle litt om dine erfaringer med appen? Hvordan brukte du den? (Hvis relevant: Hvilket språk?)</li> <li>- Var innholdet enkelt å forstå? Hva var enkelt/vanskelig?</li> <li>- Hva synes du om utforming av appen (bilder etc, viser appen)</li> <li>- Brukte du appen til å få informasjon? Lærte du noe nytt?</li> <li>- Hvilken del av appen hadde du mest/minst nytte av? (Blodsuktermåling, fysisk aktivitet, mat og drikke eller informasjon?) Hvorfor?</li> <li>- Pleide du å bruke appen hver dag? (5 ganger om dagen?) Hvorfor/hvorfor ikke?</li> <li>- Hvordan følte det å registrere blodsukkerverdiene i appen (Påvirket det deg, evt.hvordan? Hvordan var det å få glad eller sur smiley?)</li> <li>- Har du også brukt andre apper om diabetes/svangerskap?</li> <li>- Har du brukt appen også etter svangerskap? (Hvorfor/hvorfor ikke?)</li> <li>- Har du vist appen til andre?</li> <li>- Hva synes du om å registrere helsedata eller informasjon i en app?</li> <li>- Tidligere svangerskapsdiabetes? Kan du fortelle litt om dine erfaringer med å ha svangerskapsdiabetes med og uten app? Forskjeller?</li> </ul>	<p><b>Påvirkning:</b></p> <ul style="list-style-type: none"> <li>- Har du gjort noen endringer i det du spiste, det du drakk og i din mosjon etter at du fikk vite at du hadde svangerskapsdiabetes? (Hvis ja- hvilke? Hvordan var det å gjøre disse endringene? Var det lett/vanskelig? Hva var enklest, hva var mest vanskelig?) (Hvis nei: Hvorfor ikke?)</li> <li>- Brukte du oppskriftene og rådene om kosthold i appen? (Hva synes du om dem? Var de annerledes enn det du var vant til? Lærte du noe nytt?)</li> <li>- Hvordan passet rådene inn i ditt kosthold?</li> <li>- Spiste de andre i familien det samme som deg?</li> <li>- Påvirket appen hva du spiste (hvis ja- hvordan? Hvilke deler av appen påvirket?) (Hvis nei: Hvorfor ikke? Hva skal til for at en app skal påvirke hva du spiser?)</li> <li>- Brukte du forslag om fysisk aktivitet du fant i appen?</li> <li>- Brukte du appen til å registrere fysisk aktivitet?</li> <li>- Påvirket appen dine aktivitetsvaner (Hvis ja: Hvordan? Hvilke deler av appen gjorde at du ble påvirket?) (Hvis nei: Hvorfor ikke? Hva skal til for at en app skal påvirke dine aktivitetsvaner?)</li> </ul>
<p><b>Etter fødsel:</b></p> <ul style="list-style-type: none"> <li>- Har endringene du gjorde i svangerskapet med tanke på kosthold og fysisk aktivitet vedvart også etter fødsel? (Spørres kun dersom personen faktisk gjorde endringer, se spørsmål under kosthold og fysisk aktivitet.)</li> <li>- Bruker du andre apper nå om kosthold, fysisk aktivitet?</li> </ul>	<p><b>Helsepersonell:</b></p> <ul style="list-style-type: none"> <li>- Hvordan opplevde du at helsepersonell (jordmor, diabetessykepleier etc.) forholdt seg til appen? (Var de kjent med appen? Visste de hva prosjektet gikk ut på?)</li> <li>- Hvordan var rådene i appen i forhold til rådene du fikk på sykehuset? Stemte de overens?</li> </ul>	<p><b>Evaluerings:</b></p> <ul style="list-style-type: none"> <li>- Tror du Gravid+appen påvirket ditt svangerskap, evt hvordan?</li> <li>- Alt i alt- følte du at appen hjalp deg? Hva var fordelene med appen? Var det noen ulemper? Evt hvilke? Har du noen forbedringsforslag? Tror du at Gravid+appen påvirket ditt svangerskap, evt hvordan?</li> <li>- Ville du ha anbefalt appen til andre? Hvorfor/hvorfor ikke?</li> </ul>

### Avslutningsvis om Gravid+ studien:

- Kan vi spørre deg til slutt om hvordan du opplevde din deltagelse i Gravid+ studien?
- Hva var grunnen til at du ble med i studien?
- Hvordan var rekrutteringen?
- Hvordan opplevde du å svare på spørreskjemaene?
- Har du tatt en glukosebelastningstest etter fødselen? Hva tenker du om det?

## Appendix 3: Consent form



### Forespørsel om deltakelse i forskningsprosjektet



### *Erfaringer med bruk av mobiltelefon-app hos kvinner med svangerskapsdiabetes i Gravid+studien- en kvalitativ studie*

#### **Bakgrunn og formål**

Studien er en masteroppgave som inngår i Gravid+prosjektet ved Høyskolen i Oslo og Akershus. Formålet med studien er å finne ut hvordan kvinner med svangerskapsdiabetes som deltok i Gravid+studien opplevde å bruke Gravid+appen og å være med i studien.

Du er invitert til å være med i studien etter deltakelse i Gravid+studien, da du havnet i intervensjonsgruppen som fikk tilgang til Gravid+appen. Vi er veldig interessert i å høre om dine erfaringer.

#### **Hva innebærer deltakelse i studien?**

Deltakelse i studien innebærer et individuelt intervju der fokuset kommer til å være på din opplevelse av å ha svangerskapsdiabetes og å bruke en app for å håndtere det. Intervjuet vil vare i omtrent 30 minutter og vil bli spilt inn på bånd.

### **Hva skjer med informasjonen om deg?**

Alle personopplysninger vil bli behandlet konfidensielt. Bare student og veiledere i masteroppgaven, vil ha tilgang til denne informasjonen.

Prosjektet skal etter planen avsluttes 15.05-2017. Båndopptakene vil da slettes, og all informasjon om deg som fremkommer i studien vil være anonym.

### **Frivillig deltakelse**

Det er frivillig å delta i studien, og du kan når som helst trekke ditt samtykke uten å oppgi noen grunn. Dersom du trekker deg, vil alle opplysninger om deg bli anonymisert. Dersom du ønsker å delta eller har spørsmål til studien, ta kontakt med Jeanette Skar (student, telefonnummer: 406 35 053, epost: [jeanetteskar@hotmail.no](mailto:jeanetteskar@hotmail.no)) eller Laura (veileder, telefonnummer: +47 6723 6522, epost: [laura.terragni@hioa.no](mailto:laura.terragni@hioa.no))

Studien er meldt til Personvernombudet for forskning, NSD - Norsk senter for forskningsdata AS.

## **Samtykke til deltakelse i studien**



Jeg har mottatt informasjon om studien *Erfaringer med bruk av mobiltelefon-app hos kvinner med svangerskapsdiabetes i Gravid+studien*, og er villig til å delta

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(Signert av prosjektdeltaker, dato)