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A descriptive Qualitative Study on Understanding the Factors Influencing Acceptance of Wearable Device Integration in Prenatal Care

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Abstract

Prenatal care is important in ensuring the optimal health and well-being of pregnant women. Recently, there has been growing interest in integrating wearable devices into prenatal care to enhance monitoring and management during pregnancy. However, the factors influencing pregnant women's decisions to accept or reject these devises remain underexplored.

This thesis uses the Unified Theory of Acceptance and Use of Technology (UTAUT) as its framework to investigate these factors through a descriptive qualitative study. The research aims to explore the acceptability of wearable smart ring technology within a prenatal care setting. The study involved twenty pregnant women (n=20) selected via convenience sampling from maternity clinics in Turku, Finland.

Findings revealed that perceived usefulness, effort expectancy, social influence, and facilitating conditions shaped attitudes towards wearable technology and were important for acceptance and adoption. This study offers insights into integrating wearable technology into prenatal care, highlighting both barriers and facilitators of wearable technology during pregnancy.

Keywords: pregnant women, pregnancy, acceptance, Oura ring, wearable technology, smart ring, unified theory of acceptance and use of technology.

Contents

1. Introduction

Over the past decade, wearable technology has gained increasing attention for its potential to revolutionize healthcare by allowing individuals to monitor their health in real time (Hess et al., 2014; Huhn et al., 2022; Shin et al., 2019). Wearable technology devices, ranging from fitness trackers, accelerometers, smartwatches, and smart rings have been used to track physical activity, heart rate, sleep patterns, body temperature and more (Malwade et al., 2018; Niela-Vilen et al., 2022; Shin et al., 2019). While the exploration of wearable technology has made significant strides, there is a noticeable gap when it comes to its integration into prenatal care (Huhn et al., 2022).

Prenatal care is critical in maternal and infant health aimed at ensuring the health and well-being of both the mother and the developing fetus (World Health Organization 2019). Traditionally, prenatal care has been structured around periodic clinical visits and routine screenings, offering limited opportunities for continuous monitoring and personalized interventions. In comparison to the past and present years, there have been major improvements to the prenatal care. In recent years, mobile apps and wearable devices have emerged as powerful tools that contribute significantly to enhancing prenatal care. These technological innovations have changed the way expectant mothers monitor their pregnancies and interact with healthcare providers (Moranid et al., 2020; World Health Organization 2019).

This thesis explores how pregnant women in Finland adopt wearable technology through a guidance intervention that incorporates the Öura smart ring during the second trimester of pregnancy as part of maternity clinic guidance.

2. Research Background

Nowadays technology is widely used in prenatal care, thus more pregnant women use the internet to look for maternal and infant health information, and integrate the use of wearable devices and mobile applications during their pregnancies (Ginja et al., 2018; Y. Lee & Cho, 2019). However, the acceptance and rejection of such technology in the context of prenatal care remains underexplored (Huhn et al., 2022).

Wearable technologies provide individualized and convenient approaches to gather data which not only enables an individual to monitor their own health but contributes greatly to health research and more so preventive care. Some examples of wearable technology include smart rings, watches, fitness trackers, glasses, and similar other devices (Hernandez et al., 2021). The introduction of wearable technology into prenatal care holds the potential to fundamentally remodel the antenatal care process, allowing for real-time monitoring of maternal health parameters and fetal development. Devices like the Öura smart Ring, with its capabilities to capture physiological data related to sleep, heart rate, and activity levels, offer new opportunities to provide individualized prenatal care. Moreover, these wearables empower pregnant women to actively participate in monitoring their health and making informed decisions (Galea et al., 2020). The technology enables the population to have insights of their health, their potentially weakening conditions, to become more skilled at handling their symptoms and enhance their general quality of life (Burke & Kearns, 2019; Galea et al., 2020).
However, the adoption of wearable technology in the prenatal healthcare domain remains relatively under researched. And as with any technological innovation, questions of acceptance, usability, and barriers remain emerging (Shin et al., 2019).

2.1 Prenatal Care and Monitoring

Prenatal care and monitoring are critical components of maternal healthcare. It is aimed at ensuring the health and well-being of both the mother and the developing fetus during pregnancy (Goodday et al., n.d.; Kilpatrick & Ecker, 2016). Prenatal care, also referred to as antenatal care, plays a pivotal role in promoting positive pregnancy outcomes(World

Health Organization 2019, n.d.). It involves a series of medical check-ups, tests, and interventions that are designed to monitor the health of both the pregnant woman and her unborn child throughout the pregnancy period (Lynn et al., 2011; World Health Organization 2019, n.d.). One of the primary objectives of prenatal care is to identify and manage any potential risks or complications early in the pregnancy, which can significantly reduce the chances of adverse outcomes for both the mother and the baby(Y. Lee & Cho, 2019; Tsai et al., 2018).

Prenatal care is important for several reasons. Firstly, it allows doctors, mid-wives, and nurses to track and monitor the growth and development of the fetus, ensuring that it is progressing normally and without any abnormalities (Häggman-Laitila & Euramaa, 2003; Renfrew et al., 2014). Secondly, it provides an opportunity to address any maternal health issues or pre-existing conditions that may affect the pregnancy, such as pregnancy diabetes or hypertension (Birnbaum et al., 2015; Khomami et al., 2021). Thirdly, prenatal care offers expectant mothers' valuable guidance on maintaining a healthy lifestyle, maintaining or adopting proper nutrition, exercise, and emotional well-being, which are crucial for a successful pregnancy (Khomami et al., 2021). In a nutshell, prenatal care serves as a preventive measure to reduce the risks associated with pregnancy and childbirth complications (Ginja et al., 2018; Khomami et al., 2021).

2.2 Prenatal care and monitoring in Finland

In Finland, most pregnant women have their health examinations at a prenatal clinic before the fourth month of pregnancy has ended. A public health nurse at the clinic periodically assesses the mother's condition, the baby's growth, and the welfare of the entire family, as prenatal care is family focused as opposed to focusing only on the pregnant mother (Ministry of Social Affairs and Health, 2013). During the pregnancy, the prenatal clinic offers about eight to ten appointments with a public health nurse and two appointments with a doctor, the number of visits vary depending on individual circumstances (Ministry of Social Affairs and Health Finland, 2010). During the visit at the prenatal clinic, the public health nurse measures the blood pressure, hemoglobin levels, weight, any swelling or the presence of sugar and protein in urine. The nurse

also checks the fetal heartbeat, position, and movement of the fetus. Also, if needed, extra time is allocated to talk about psychosocial problems including quitting smoking, pregnancy worries, and anticipated social support in the postpartum period (Schmidt & Bachmann, 2021).

Public health nursing care is beneficial to good quality maternal health care. According to studies done in the Netherlands and Sweden, the quality of the care an expectant mother receives through the pregnancy journey and delivery of the child has an immediate and long-term effect on her overall wellness (Baas et al., 2015; Hildingsson & Thomas, 2007). Public health nurses practicing in antenatal clinics focus on giving holistic care to the pregnant women. This involves protecting the pregnant women's health, infant mortality, disease prevention and also health promotion themes like smoking cessation, and weight management (Julia Sanders et al., 2017; McLellan et al., 2019). They also offer support that can improve stress management thus improving pregnancy outcomes (Khomami et al., 2021).

In Finland, midwives and public health nurses are fundamental healthcare providers responsible for antenatal guidance and care (Häggman-Laitila & Euramaa, 2003). Through the journey of pregnancy, the pregnant women in Finland engage with the public health nurse during prenatal care and also, for postnatal support in the first year postpartum (Häggman-Laitila & Euramaa, 2003; Tuovi Hakulinen et al., 2020). As the engagement of pregnant women and public health nurses is continuous during pregnancy and postpartum, it is fundamental for all participants to collaborate in wellbeing management (Hildingsson & Thomas, 2007; Walker et al., 2019) .

Although the pregnant women have eight to ten prenatal clinic visits for normal pregnancies, there are still gaps in continuous monitoring which often results to delayed interventions. The wearable devices worn by the pregnant women could lessen these gaps by continuous tracking of the vitals such as heart rate, sleep patterns, and physical activity levels. (Runkle et al., 2019). By integrating the data generated from the women's data and stored and analysed in the cloud into prenatal care, healthcare

providers can gain valuable insights into the pregnant individual's health status and offer more personalized and timely interventions (Runkle et al., 2019; Wakefield et al., 2023). In-spite of the wearable technologies having much potential to upgrade the prenatal care process, the acceptance or rejection of the technology can be influenced by many factors (Meier et al., 2020; van Heerden et al., 2023). During pregnancy, pregnant women have special emotional and physical circumstances that could contribute to the acceptance or rejection of wearable device integration in the prenatal care process. Concerns arise about the data privacy, device usability, perceived relevance of the data, and the impact on the overall prenatal care experience (van Heerden et al., 2023; Wakefield et al., 2023). Additionally, the collaboration between pregnant individuals and their public health nurses, who play an important role in antenatal care, may be affected by the introduction of wearable device data (Pannase et al., 2022; Runkle et al., 2019b).

2.3 Wearable Technology in Prenatal care

The introduction of wearable technologies into prenatal care has introduced new ways of maternal care and health monitoring (Ginja et al., 2018). Wearable technology is defined as any type of device that can be physically worn on the body and has a software that relays data via internet to a cloud service offering in some cases immediate feedback (Malwade et al., 2018; Shin et al., 2019; Zhang et al., 2020). These wearable devices ranging from fitness trackers to smartwatches, smart rings, etc. have sensors and advanced data processing capabilities, enabling continuous data collection and analysis (Niela-Vilen et al., 2022; Wang et al., 2014). The technology has extensive applications in various prenatal care areas, significantly benefiting pregnant women and healthcare professionals (Ginja et al., 2018; Maugeri et al., 2023; Walter et al., 2022). One of the primary uses is self-monitoring through the pregnancy time (Li et al., 2016; Malwade et al., 2018). Through wearable technology and cloud data, healthcare providers can also continuously check the patients' vital signs in present time with wearable devices tracking heart rate, blood pressure, and oxygen saturation. This data is valuable for pregnant individuals in self-monitoring and allowing for early interventions and reducing adverse effects (Novick et al., 2022).

Wearable technology also significantly impacts a pregnant woman's health by promoting a healthy lifestyle, thus contributing to preventive care other than curative care (Walter et al., 2022). The integration of fitness trackers, intelligent rings, and smartwatches, into an individual's the daily life has become common tools for individuals striving to enhance their well-being (S. Y. Lee & Lee, 2018; Sultan, 2015). These wearable devices have been shown to promote and maintain an active living to pregnant women during the pregnancy period, which is crucial for both maternal and health of the unborn child. Wearable devices encourage physical activity by tracking steps, calories burned, and exercise duration (Smith et al., 2022). Research indicates that pregnant individuals who use wearable technology are more likely to meet recommended activity guidelines. The physical activity not only improves cardiovascular health but also boosts mood and reduces stress levels (Jia et al., 2018; Niela-Vilen et al., 2022; Shin et al., 2019). Pregnancy can also be accompanied by increased levels of stress and anxiety (Dunkel Schetter & Tanner, 2012; Shahhosseini et al., 2015). Wearable devices with stress-tracking features enable pregnant individuals to monitor their stress levels throughout the day. By gaining insights into stress patterns and triggers, individuals can implement coping strategies such as mindfulness, relaxation techniques, or seeking social support (Jimah et al., 2021). Studies have demonstrated that regular monitoring of stress levels using wearable technology is associated with improved emotional well-being and reduced risk of prenatal depression (Jimah et al., 2021; Leonard et al., 2023; Whitaker et al., 2022).

Wearable device real-time feedback provides users with a clear understanding of their daily activity, motivating them to meet and surpass their goals (Huhn et al., 2022). In this way, incorporating wearables into daily life promotes a culture of movement and exercise (Godfrey et al., 2018; Huhn et al., 2022; Jia et al., 2018).

Some wearable devices also excel in tracking sleep patterns (Alzueta et al., 2022; De Zambotti et al., 2017; Henriksen et al., 2022). According to researchers, it is important to get sufficient sleep-in order to ensure optimal health (Chee et al., 2021; Chinoy et al., 2022; Mehrabadi et al., 2020). By monitoring sleep duration, quality, and

interruptions, wearables offer insights into one's sleep habits. Users can identify sleep deficiencies and disturbances, helping them make necessary adjustments to improve sleep hygiene (Stone et al., 2020). These devices also encourage the establishment of consistent sleep schedules, which is beneficial for overall pregnant person's health and cognitive function. The data derived on sleep quality encourages individuals to prioritize and invest in better sleep habits (Henriksen et al., 2022).

2.4 Technology Acceptance

An important aspect that determines the use of wearables in pregnancy and prenatal care settings is their acceptance (Thomas et al., 2022). Technology acceptance can be defined willingness of a consumer to use information technology for the purposes for which it is designed (Dillon, 2001). Research in technology acceptance in numerous fields has been done over the years, however, research in acceptance of wearables in prenatal care settings is still lacking (Huhn et al., 2022; Maugeri et al., 2023).

In order to understand technology acceptance, several theories (Alshammari & Rosli, 2020; Venkatesh et al., 2003) have been proposed including the Unified Theory of Acceptance and Use of Technology (UTAUT). In this study, UTAUT is the theoretical framework that was used to understand the acceptance or rejection of wearable technology in a prenatal care setting. The Unified Theory of Acceptance and Use of Technology is a theoretical framework that has been used by researchers in different settings including healthcare and has shown its applicability in understanding technology in healthcare settings (Barutçu et al., 2018; Lai, 2017). UTAUT integrates various technology acceptance models and theories to provide an understanding of technology adoption. UTAUT was developed by Venkatesh and colleagues (Venkatesh et al., 2003) and seeks to understand the different reasons that influence individuals' intention to use technology and their actual usage. UTAUT as shown in (Figure 1), considers several variables, which include performance expectancy, effort expectancy, social influence and facilitating conditions (Lai, 2017; Venkatesh et al., 2003).

2.4.1 Performance Expectancy

Performance expectancy is defined as the extent to which the consumer of technology believes the use of it will contribute to perform tasks more effectively (Venkatesh et al., 2003). In a prenatal care setting, it shows how wearable technology would improve the pregnant persons' self-monitoring, monitoring, and management of pregnancy. According to the research, performance expectancy aspect within the different available acceptance models, is the most accurate indicator of intention and is significant at all times of assessment in both voluntary and required situations (Lai, 2017; Venkatesh et al., 2003).

2.4.2 Effort Expectancy

Effort expectancy is another aspect of UTAUT which examines the extent to which users believe technology to be simple to use and to understand. According to studies done on adoption of technology, effort expectancy is more strong on how it affects the behavioral intention to accept the technology in the early stages of experiencing it and also the gender and age are contributors (Jia et al., 2018; Shin et al., 2019; Venkatesh et al., 2003).

2.4.3 Social Influence

This represents the extent to which the user's decision to use technology is affected by other people's opinions or recommendations. In a prenatal care setting, this could relate to the influence of healthcare providers or other pregnant women who have used wearable technology (Barutçu et al., 2018; Venkatesh et al., 2003).

2.4.4 Facilitating Conditions

Facilitating conditions refer to the support and resources available to users to facilitate technology use. This might include the availability of necessary infrastructure and training for using wearable technology in prenatal care (Barutçu et al., 2018; Venkatesh et al., 2003).

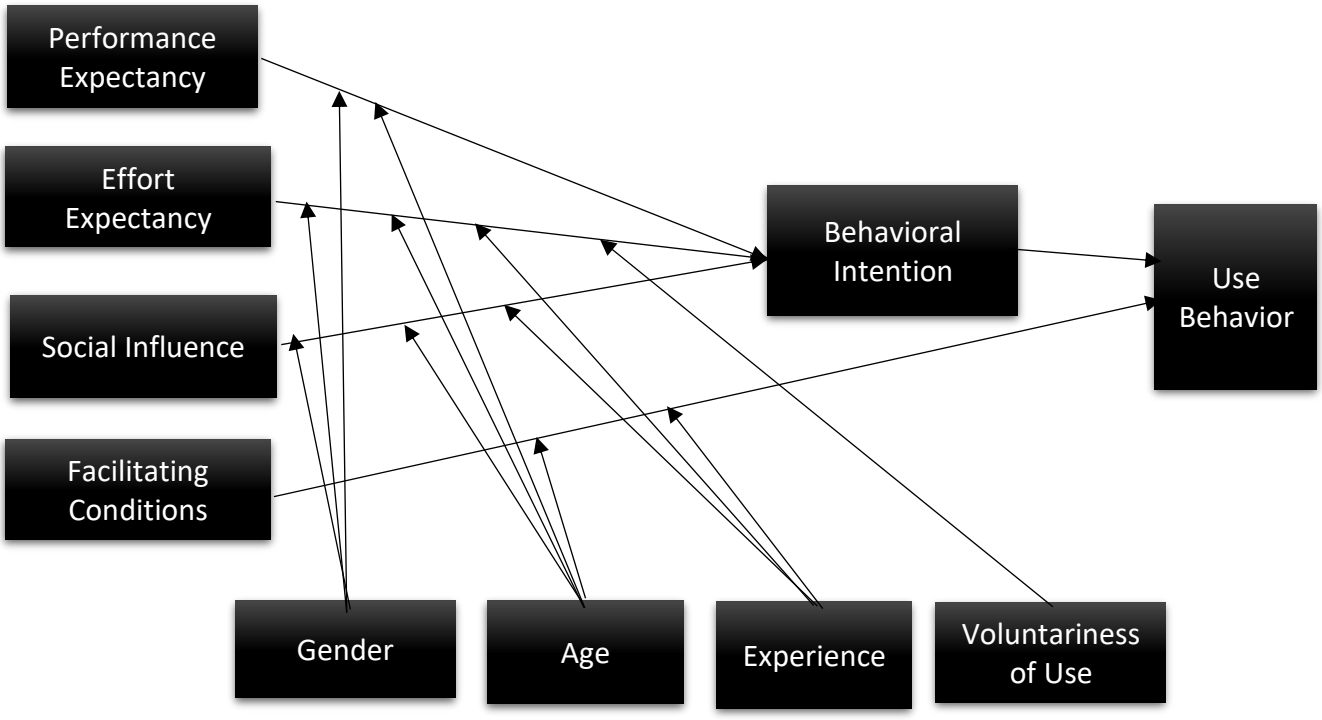


Figure 1: Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003)

3. Literature review

3.1 Purpose of the literature review

The purpose of the literature review of this study was to gain knowledge about the existing research regarding wearable technology integration and factors contributing to acceptance or rejection within prenatal care setting. The research question guiding the literature review was: What factors influence pregnant women's decisions to accept or reject the integration of wearable device into their prenatal care.

3.2 Data collection search methods

For the search strategy of the literature review, the PI(C)OS terms that best correspond to the research questions were first prepared. The purpose of their use was to increase the evidence-based nature of the review because they enable the researcher to prepare high-quality research questions (Saaiq & Ashraf, 2017). Seven databases were searched, these include: CINHAL, PubMed, Web of Science, Scopus, Cochrane, ScienceDirect and Embase. The inclusion criteria was based on PI(C)OS: the Population (Pregnant women and public health nurses/ health providers), Phenomena of interest (Integration of wearable device data into prenatal care), No object C (comparison) to be compared was defined in the search. Outcome (Factors influencing acceptance/rejection of integration and the impact on overall prenatal care experience), Design of studies was added to define the desired research layout (Hammarberg et al., 2016; Saaiq & Ashraf, 2017) which was limited to qualitative, mixed method studies and feasibility studies. The criteria for inclusion were applied to evaluate the eligibility of the studies (Aromataris & Pearson, 2014).

3.2.1 Inclusion and exclusion criteria

In the search for articles to include in this master thesis, the inclusion and exclusion criteria of the studies were defined. Available studies in English were selected for the thesis, where the target group of the study was pregnant women and wearable device

were used in the intervention. More specifically the pregnant women using the wearable device for self-measurement. In addition, the studies had to consider the patient's perspective. (Garg, 2016; Patino & Ferreira, 2018). The exclusion criteria for the studies in the thesis were studies that involved interventional wearable devices that were only used by healthcare professionals, or the intervention was not based on self-measurements made by pregnant women with wearable devices as an intervention. Secondly, studies that did not use wearable devices as part of the intervention were excluded in this study. Lastly, studies that had not published their findings. (Garg, 2016; Patino & Ferreira, 2018).

P	I	C	O	S
Pregnan* Expectant mothers Prenatal care Antenatal care Maternal care Antenat* maternal*	handheld* OR mobile* OR pda OR "handheld PC*" OR "personal data assistant*" OR MH "Computers, Hand-Held+" OR "Handheld Computers" OR ipad* OR "tablet computer*" OR "tablet PC*" OR iphone* OR smartphone* OR "cell phone*" OR "cellular phone*" OR "Cell Phones" OR "mobile phone*" OR "mobile device*" OR wireless* OR mHealth* OR "Telemedicine" OR "mobile health*" OR "m-Health*" OR eHealth* OR Wearable* OR "Health Tech*" OR app OR apps* OR application* OR "application program*" OR "Mobile Application*" OR "Mobile Medical App*" OR "fit bit*" OR "oura ring*" OR "smart watch*" OR smartwatch OR "wearable computer" OR "wearable device" OR "smart band" OR "iphone" OR "smartphone*" OR "android*" OR "fitness track*" OR "activity track*" OR "facebook app*" OR "MyfitnessPal" OR "google fit*"		"Technology Acceptance Model*" OR TAM* OR Technology Adoption* OR Perceived Ease of Use * OR " Perceived Usefulness*" OR " Behavioral Intention to Use*" OR "PEOU" OR "Attitude Toward Technology*" OR "User Satisfaction*" OR "IT Adoption Models" OR User Interface Design OR " Attitude Toward Technology " OR " perceived ease of use" OR " Barriers to technology adoption" OR " wearable device rejection" OR " wearable device refusal"	feasibility OR exploratory OR mixed-method* OR "mix method*" OR "mixed method*" OR MH "qualitative stud*" OR "qualitative method*" OR "qualitative" OR narratives OR "thematic analysis" OR interviews OR MH "Phenomenology" OR MH "Phenomenological Research" OR "Technology Adoption Case Studies"

Figure 2: Illustrating Search Terms

4. Literature search process

The literature search involved a continuous process of identifying and selecting relevant articles. At first a preliminary search was done using broad terms to find many articles relating to the topic and have a basic understanding of the current existing research (Tawfik et al., 2019). By searching key words like ‘prenatal care’, ‘wearable device’ and ‘acceptance or rejection’ major themes within the topic were identified thus gaining insights and more in depth understanding of the thesis’s topic, and identified gaps or topics where further investigation is needed. This preliminary search was then followed by a more refined search for articles. This involved diving deeper into the literature and focusing on specific aspects of the research question: ‘What factors influence pregnant women’s decisions to accept or reject the integration of wearable device data into their prenatal care?’. To achieve this, more precise key words were applied to narrow the search results as seen above in the PI(C)OS table (Table 1). Data searches were done in 7 different data bases which were PubMed, CINAHL, Web of Science, Embase, Science Direct, Cochrane and Scopus . A more detailed description of the search terms used in the database search can be found in the appendix section.

A total of 1239 articles were identified from the database search, (n=53) were duplicates, leaving (n=1186) articles for screening. After reading the abstract according to the inclusion and exclusion criteria, (n=983) articles were excluded as they were not applicable to the research theses topic and research questions. Full texts (n= 203) were then assessed for eligibility, (n=10) met the inclusion criteria and were appraised by the Joanna Briggs Institute appraisal checklist, they were deemed to be good of quality (Tufanaru C, Munn Z, Aromataris E, Campbell J, 2017) thus were accepted for the review of this thesis. The Prisma flow chart (Figure 3) describes the literature search process.

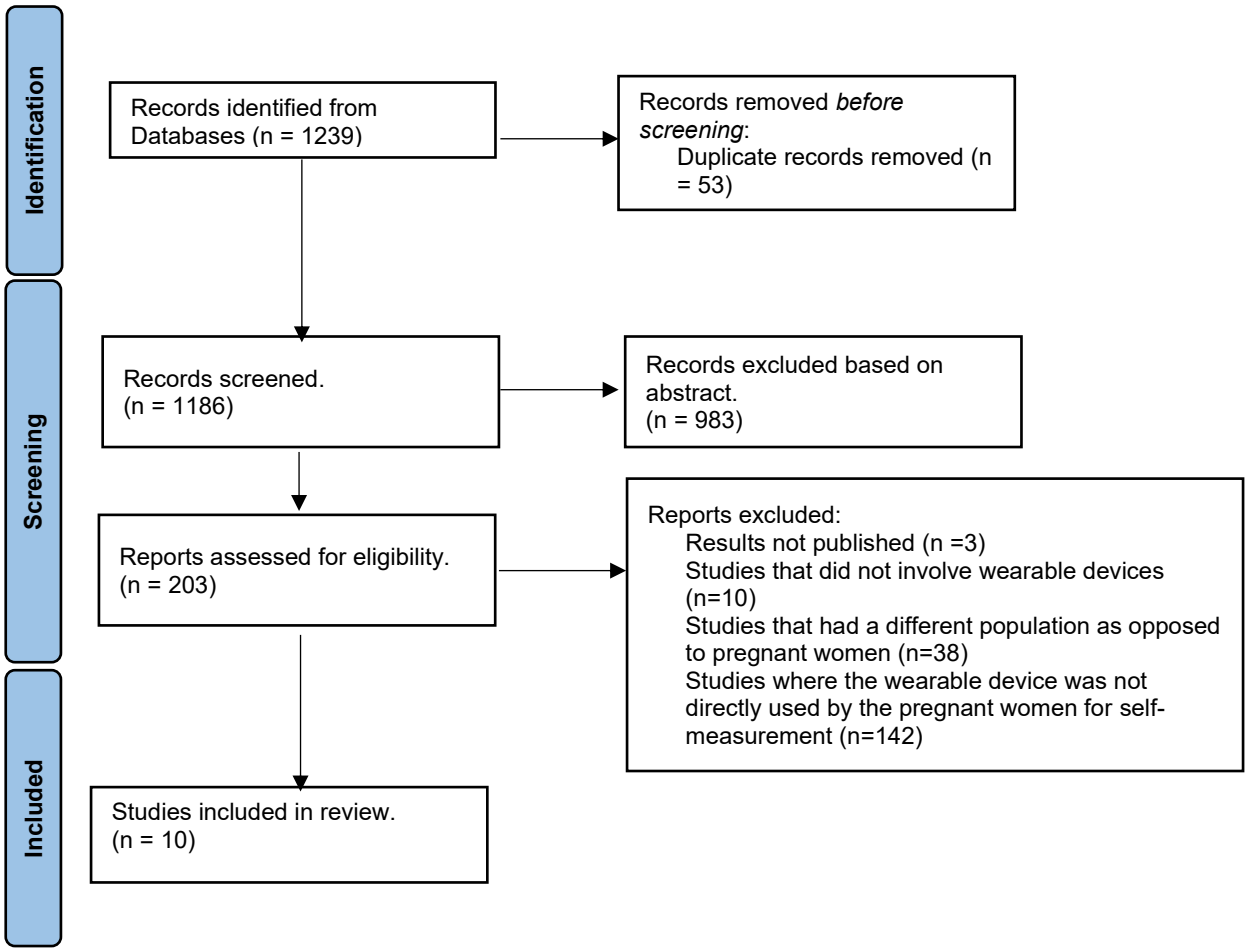


Figure 3: Prisma Flow Chart (Page et al., 2021)

4.1 Data extraction

The studies selected for the thesis were extracted in terms of their authors, years of publication, countries, research purpose and feasibility study perspective, research approach, research methods, participants, and results. In addition, the studies were analyzed with regard to the unified theory of acceptance and use of technology framework (UTAUT). The studies showed different perspectives of technology acceptance or rejection with regard to prenatal care. Some of the key themes and insights derived from these studies to better understand the complex dynamics surrounding the use of wearable devices during pregnancy and postpartum periods include wearable device usage (Kominiarek et al., 2019a; Sarhaddi et al., 2021a;

Whitaker et al., 2022b), the factors that affected usage (Ehrlich et al., 2021; Kominiarek et al., 2019; Leonard et al., 2023), satisfaction and user experience (Cheung et al., 2019; Grym et al., 2019; Jimah et al., 2021; Kominiarek et al., 2019) and also interest and perceived behavioral changes (Leonard et al., 2023; Schramm et al., 2019; Thomas et al., 2022).

4.2 Description of studies

Articles selected for the literature review were published between 2019 and 2022. These studies were done in Finland (n=2), United States (n=4), Canada (n=2), Germany (n=1), Australia (n=1). Most of the studies were done by use of mixed methods (n=8) and quantitative research method (n=2). The quantitative research designs used were a randomized controlled trial (n=1), a cross-sectional study (n=1). The studies that used both quantitative and qualitative research methods used cohort research methods (n=8) in addition to a descriptive qualitative approach. These studies utilized wearable devices to enhance prenatal care, focusing on physical activity, weight monitoring, and tracking health parameters in pregnant women. Common devices used include the Fitbit Charge 3, Fitbit Flex, Fitbit Inspire wrist monitor, activPAL3 micro, Oura smart ring, Withings Activite Pop PA tracker, Garmin VivoSmart HR smart wristbands, Breezing device, and Samsung Gear Sport smartwatch. These studies aimed to assess the accuracy of step counts, measure resting energy expenditure, and promote self-monitoring of physical activity and sedentary behavior.

Wearable devices were often integrated with complementary tools such as text messaging programs, mobile apps, and web-based telemetric physician consultations. The research methodologies varied, including continuous weekly measurements, pilot randomized controlled trials, and mixed-method approaches. These studies typically targeted pregnant women with conditions like gestational diabetes mellitus, overweight, or obesity, aiming to provide objective measures for assessing the effectiveness of the interventions and enhancing overall maternal health monitoring throughout pregnancy and postpartum.

The use of these wearable technologies in the studies provided insights into their practicality, user acceptability, and potential for integrating into traditional prenatal care. These interventions underscored the potential of combining wearable devices with digital health tools to support the well-being of pregnant women.

Overall, wearable technologies offer diverse functionalities, including activity tracking, physiological monitoring, and intervention support, making them valuable tools in maternal health research and clinical practice, with the potential to enhance personalized care and improve outcomes for pregnant women. The studies are described in detail in table 1. Found in the appendix section.

The studies (n=10) were evaluated according to the evaluation criteria applicable to their research design. The Joanna Briggs Institute evaluation criteria was used as an evaluation criterion. The answer ‘yes’ was awarded one point and ‘no’, ‘not clear’ or ‘not applicable’ was awarded zero points. The ten studies average scores were higher than 70% and were classified as being of high quality, therefore, were included in this master thesis.

4.3 Results of the literature review

Prenatal care is an important process for pregnant individuals and more importantly contributes greatly to maternal health (Sarhaddi et al., 2021). In the selected studies, integration of wearable devices during the pregnancy journey has been explored as a means to enhance monitoring and management during pregnancy. The synthesis of data findings from multiple studies highlights several key themes and insights that influence the acceptance and rejection of wearable device data integration in prenatal care.

4.3.1 Perceived usefulness of wearable technology on pregnancy outcomes

This theme can be defined as the measurement to which a person believes that using a particular technology would be instrumental to own health (Venkatesh et al., 2003). Therefore, if there is high perception of usefulness by using a certain wearable technology, then there is high probability of the person's intention to use the technology (Venkatesh et al., 2003). In this instance, if the pregnant women believed that the wearables would help monitor their health, or provide valuable advice into their wellbeing, they would be more likely to accept the technology (Schramm et al., 2019). The findings of the various studies in this research regarding the perceived usefulness of wearable technology among pregnant women, revealed several common themes and differences across different types of devices and interventions. Overall, the findings suggest a positive attitude towards wearable technology for monitoring physical activity, pregnancy health, and general well-being (Jimah et al., 2021; Kominiarek et al., 2019; Schramm et al., 2019; Whitaker et al., 2022). Despite some technical challenges and individual preferences, pregnant women generally perceived wearable technology as beneficial for enhancing their health during pregnancy and postpartum periods.

One consistent theme across the all studies (n=10) was the willingness of pregnant women to engage with wearable technology for monitoring various health parameters (Kominiarek et al., 2019; Leonard et al., 2023; Thomas et al., 2022; Whitaker et al., 2022) .Whether it's tracking physical activity, monitoring general well-being, or

managing gestational weight gain, pregnant women across different studies expressed interest in using wearable devices as complementary tools to traditional healthcare practices (Jimah et al., 2021; Kominiarek et al., 2019; Thomas et al., 2022; Whitaker et al., 2022). This willingness to engage showed a positive perceived utility of wearable technology in supporting prenatal care and promoting healthier behaviors during pregnancy (Venkatesh et al., 2003) .

Another common finding was the importance of user experience and satisfaction with wearable devices. Regardless of the specific technology used, the pregnant women consistently reported high levels of satisfaction with the devices, indicating ease of use, comfort, and perceived effectiveness in helping them achieve their health goals (Cheung et al., 2019; Grym et al., 2019; Koech et al., 2022; Sarhaddi et al., 2021) . Positive user experiences contribute to the perceived usefulness of wearable technology, as individuals are more likely to continue using devices that they find beneficial and enjoyable (Dillon, 2001; Schretzlmaier et al., 2022).

Additionally, the integration of wearable technology into daily life emerged as another factor influencing its perceived usefulness. The pregnant women appreciated features that allowed seamless integration of devices into their routines, such as automatic data collection, personalized feedback, and compatibility with existing technologies like smartphones (Cheung et al., 2019; Ehrlich et al., 2021; Koech et al., 2022; Sarhaddi et al., 2021) . This integration enhanced the practicality and convenience of the wearable technologies, that made it more likely to be adopted by the users and sustained over time (Utomo et al., 2021; Venkatesh et al., 2003).

Furthermore, the perceived usefulness of wearable technology varied based on the specific features and functionalities offered by different devices and interventions. While some studies focused on activity tracking and physical fitness, others explored managing gestational weight gain (Cheung et al., 2019; Jimah et al., 2021; Kominiarek et al., 2019; Thomas et al., 2022). Participants' preferences for specific features, such as real-time feedback, comprehensive data monitoring, or integration to prenatal care

and collaborating with healthcare professionals, highlighted the importance of tailoring wearable technology to meet the diverse needs of pregnant women.

Even though the studies show positive perception to the wearable technology among pregnant women, challenges such as technical issues, adherence, and individual preferences were also evident across the studies (Kominiarek et al., 2019; Schramm et al., 2019; Whitaker et al., 2022) . Addressing these challenges through improved device design, user support, and technical assistance is essential for maximizing the perceived usefulness and acceptance of wearable technology among pregnant women (Kominiarek et al., 2019; Schramm et al., 2019; Thomas et al., 2022; Whitaker et al., 2022).

The studies demonstrated that wearable technology holds promise as a valuable tool for monitoring physical activity, pregnancy health, and overall well-being among pregnant women (Jimah et al., 2021; Leonard et al., 2023; Schramm et al., 2019; Thomas et al., 2022). Factors such as willingness to engage, positive user experiences, seamless integration into daily life, and tailored features contributed to the perceived usefulness of wearable devices in supporting prenatal care. Thus, by managing the challenges, the use of wearable technologies can upgrade the traditional prenatal care practices (Runkle et al., 2019).

4.3.2 Effort expectancy

The integration of wearable technologies into maternal health monitoring presents a promising avenue for promoting well-being during pregnancy(Domb, 2019; Penders et al., 2015). Across the studies reviewed, pregnant women exhibited varying degrees of effort expectancy towards these technologies, influenced by factors such as acceptance, ease of use, and perceived benefits (Kominiarek et al., 2019; Leonard et al., 2023; Thomas et al., 2022). However, despite the positive reception, certain factors and challenges also emerged that hindered effort expectancy.

The pregnant women consistently demonstrated a willingness to engage with wearable devices, reflecting a positive attitude towards utilizing technology for health monitoring. This was evident in their acceptance of physical activity monitoring using devices like the Fitbit Charge 3, as well as their interest in comprehensive pregnancy monitoring through smart devices(Cheung et al., 2019; Kominiarek et al., 2019; Whitaker et al., 2022). The pregnant women were found to prefer the convenient activities such as walking, and there was also the desire for the detailed monitoring which emphasized their proactive approach towards leveraging the wearable technologies to enhance their pregnancy experience (Kominiarek et al., 2019).

The pregnant women also valued the ability of wearable devices to facilitate goal setting and progress tracking, indicating a perceived effectiveness in supporting behavior change. The positive feedback regarding usability and satisfaction with the devices highlighted their perceived utility in promoting health-related behaviors such as increased physical activity and improved sleep quality (Ehrlich et al., 2021; Grym et al., 2019; Schramm et al., 2019). Additionally, technological literacy among pregnant women, demonstrated through high smartphone usage and internet access, facilitated their engagement with wearable technologies (Kominiarek et al., 2019; Leonard et al., 2023; Sarhaddi et al., 2021)

However, technical issues such as syncing problems and device discomfort were reported across several studies, leading to frustration and dissatisfaction among participants and took away from the effort expectancy. These challenges hindered the seamless integration of wearable technologies into daily routines and undermined the user experience, impacting overall engagement and adherence to monitoring protocols (Grym et al., 2019; Leonard et al., 2023; Sarhaddi et al., 2021).

Furthermore, while pregnant women expressed interest in using wearable devices for monitoring their health, some studies (n=6) revealed a discrepancy between intentions and actual usage. Despite initial enthusiasm, participants in some studies exhibited lower-than-expected compliance rates with wearing the devices consistently(Grym et

al., 2019; Sarhaddi et al., 2021). This inconsistency may be attributed to various factors, including competing demands on participants' time and attention, as well as the perceived burden of continuous monitoring. Additionally, concerns about data privacy and security may have contributed to hesitancy in fully embracing wearable technologies for health monitoring (Schramm et al., 2019)

Moreover, while pregnant women generally demonstrated a positive attitude towards wearable technologies, there were instances where participants expressed doubt or resistance. For example, in one study, pregnant women expressed reservations about relying solely on wearable devices for pregnancy monitoring, preferring instead to supplement technology with traditional consultations with healthcare professionals (Schramm et al., 2019). This shows the importance of integrating wearable technologies into existing healthcare practices rather than replacing them entirely, to ensure acceptance and trust among pregnant women (Domb, 2019; Penders et al., 2015; Tu & Gao, 2021).

Overall, while the pregnant women in general showed effort expectancy towards wearable technologies for pregnancy health monitoring, challenges and limitations were also highlighted. Technical issues, compliance barriers, and skepticism towards technology adoption posed obstacles to seamless integration and user engagement. Addressing these challenges through user-centered design, improved technical support, and enhanced privacy measures is crucial for optimizing the effectiveness and acceptance of wearable technologies in maternal health care. Additionally, fostering collaboration between healthcare providers and technology developers can ensure that wearable devices complement existing healthcare practices, enhancing patient outcomes and experiences during pregnancy (Jimah et al., 2021; Kominiarek et al., 2019; Schramm et al., 2019; Whitaker et al., 2022)

4.3.3 Social influence

Social influence in this thesis research referred to how pregnant women’s decision making is affected by the perceptions of others such as family, peers and or health providers. This theme of social influence was presented in six studies, (n=6) and it was

evident that it is an important factor contributing to acceptance of wearable technology by pregnant women.

One consistent finding across the studies is the high commitment of pregnant women to self-monitoring which is made easier by use of wearable technology. This commitment indicated a willingness among participants to engage with the technology, promoting the feeling of accountability and the potential benefits associated with improved health outcomes(Cheung et al., 2019; Grym et al., 2019; Jimah et al., 2021; Sarhaddi et al., 2021) . Peer recommendations emerged as a factor influencing pregnant women's engagement with wearable technology(Cheung et al., 2019; Kominiarek et al., 2019; Whitaker et al., 2022). Positive feedback from peers not only encouraged participants to utilize the technology themselves but also motivated them to recommend it to others within their social circles(Cheung et al., 2019). Thus, social influence played a role in initiating and sustaining engagement with wearable technology among the pregnant women.

The pregnant women also appreciated the accountability and motivation provided by group settings, which fostered a sense of collective support and encouragement. The studies also showed that the pregnant women in the study interventions wanted to improve their pregnancy health which highlighted the influence of social dynamics, where the pregnant women were influenced by each other's suggestions and preferences (Cheung et al., 2019; Thomas et al., 2022).

The involvement of healthcare professionals, such as physicians, midwives, and health coaches, emerged as a significant factor influencing pregnant women's acceptance and adoption of wearable technology (Ehrlich et al., 2021; Schramm et al., 2019; Thomas et al., 2022). Recommendations from healthcare providers carry substantial weight and increases the rate at which pregnant women to engage with the technology (Watt et al., 2019). Moreover, personalized support and guidance provided by professionals enhance participants' engagement and adherence to interventions (Alim & Imtiaz, 2023; Bove, 2019; Watt et al., 2019). This underscores the importance of

integrating healthcare professionals into wearable technology interventions to take advantage their expertise and facilitate user acceptance (Nasir & Yurder, 2015; Watt et al., 2019).

The findings from the studies underscore the role of social influence in shaping pregnant women's engagement with wearable technology during pregnancy. Peer recommendations, group dynamics, and professional endorsement, showed to be as key factors influencing technology adoption and adherence among pregnant women.

4.3.4 Facilitating conditions.

In pregnancy care and wearable technology, the idea of putting facilitating conditions in place to ensure the successful adoption and integration of the technology is key (Venkatesh et al., 2003). The findings from the studies in this literature review explore how facilitating conditions are represented and play a key role in shaping wearable technology acceptance.

User-centered design and perceived utility of wearable technology was identified a factor in highlighting the facilitating conditions in wearable technology. Devices like Fitbit Flex, Fitbit Inspire, and Öura ring were chosen for their user-friendly design and perceived usefulness in monitoring health parameters such as physical activity levels, sleep patterns, and heart rate. (Ehrlich et al., 2021; Jimah et al., 2021; Kominiarek et al., 2019). Pregnant women expressed high interest and acceptance in using wearable technology, motivated by the potential health benefits and ease of integration into their daily lives. This positive attitude towards the technology, coupled with its perceived utility, fosters acceptance and adoption among users (Venkatesh et al., 2003).

Another facilitating condition that was identified from the studies was the integration of wearable technology into broader intervention programs and healthcare systems. Studies demonstrated that integrating wearable technology with coaching sessions, educational platforms like Healthie app, and clinical healthcare systems enhanced user experience and supported sustained engagement (Ehrlich et al., 2021; Kominiarek et al., 2019; Sarhaddi et al., 2021; Whitaker et al., 2022). The integration of wearable

technology into existing healthcare infrastructure, pregnant women would receive comprehensive support and guidance throughout their pregnancy journey (Ehrlich et al., 2021; Leonard et al., 2023; Schramm et al., 2019). This integration ensured that wearable technology is not working alone but an integral part of the healthcare ecosystem, enhancing its acceptance and adoption(Chau et al., 2019; Shin et al., 2019).

Providing adequate technical support and real-time feedback to address user concerns and enhancing technology acceptance was seen a factor supporting facilitating conditions. Studies highlighted the importance of researchers' support in addressing technical issues, troubleshooting, and providing training to users. (Kominiarek et al., 2019; Leonard et al., 2023; Thomas et al., 2022). Additionally, wearable technology's ability to provide real-time feedback on health metrics and support goal setting was important for promoting behavior change and sustaining user engagement.(Chuah et al., 2016; Jimah et al., 2021; Shin et al., 2019) Features such as activity tracking, personalized feedback, and goal setting enhanced user motivation and accountability, contributing to the overall success of wearable technology interventions.

Lastly, user privacy and data security, providing clear educational materials, and conducting longitudinal monitoring were additional facilitating conditions that promoted wearable technology adoption. Implementing robust security measures, educating users about the benefits and functionalities of wearable technology, and conducting longitudinal studies provided reassurance to users and valuable insights into user behavior over time (Sarhaddi et al., 2021; Schramm et al., 2019).

The analysis of the studies indicated that while not all the studies specifically explored all the technology acceptance themes as demonstrated above, various aspects indirectly touched upon the themes. Perceived usefulness of the wearable technology, facilitating conditions, including the availability of technology, support from healthcare providers, training, and technical assistance, indirectly affected the acceptance and usability of wearable technology in prenatal care.(Cheung et al., 2019; Grym et al.,

2019; Jimah et al., 2021; Koech et al., 2022) The role of social influence from healthcare providers, peers, and user recommendations was also important in shaping pregnant women's attitudes and preferences toward these technologies.(Whitaker et al., 2022)

5. Research Aim

The primary aim of this thesis was to explore the acceptability of wearable smart ring technology in prenatal care by understanding the factors influencing pregnant women's decisions to accept or reject these devices. This thesis addresses the gap in existing research, which has largely focused on technical functionalities rather than the subjective experiences of pregnant women.

5.1 Purpose and research question.

The purpose for this study was to explore the factors that encourage the acceptability or rejection of wearable smart ring technology within a prenatal care setting.

5.2 Research question:

1. What factors influence pregnant women's decisions to accept or reject the integration of wearable device data into their prenatal care?

6. Research Methodology

6.1 Research Design

This research was conducted by using descriptive qualitative design to explore and understand the factors influencing the acceptance and rejection of wearable device data integration in prenatal care. Descriptive qualitative research seeks to provide a comprehensive and in-depth exploration of reasons that influence pregnant women to accept or reject wearable technology, allowing for the development of different perspectives and knowledge from the point of view of participants (Braun & Clarke, 2006; Nowell et al., 2017). Furthermore, given the exploratory nature of this thesis research,

this approach is well suited for showing different variables that affect a pregnant women's decision regarding wearable data device data integration and how this affects the overall prenatal care experience. Thematic analysis was then applied for the data analysis providing a systematic and flexible framework for identifying, analyzing, and reporting patterns within qualitative data (Braun & Clarke, 2006; Nowell et al., 2017).

6.2 Analysis of qualitative data

This thesis research involved conducting a secondary analysis of qualitative data, the data used in this study was from interviews that were originally collected as part of a separate research project conducted in the University of Turku in 2020. The data was collected between March and October 2020. The primary research aimed to evaluate the feasibility of an intervention using a smart ring with pregnant women, particularly focusing on their well-being and guidance support. The research questions of the original study were: 1. How does the guidance intervention support the pregnant person's commitment to promoting their own well-being as part of counseling? 2. How appropriate do the public health nurses feel the use of the guidance intervention as part of supporting the stress management and well-being of the pregnant women? The primary aim of the original study was to assess whether an intervention using a smart ring, specifically the Oura smart ring, could be implemented in the future, possibly in a larger study.

The purpose of my thesis research was to assess the factors influencing the acceptability or rejection of wearable technology, specifically the Oura smart ring, within a prenatal care setting. The aim of the research is to offer a deep and comprehensive understanding of the factors influencing pregnant women decisions on wearable device data integration and how these factors affect their overall prenatal care experience.

6.2.1. Rationale for the secondary analysis of the qualitative data

This thesis research employed a secondary analysis methodology to investigate the lived experiences of wearable technology during pregnancy through qualitative data

collected with twenty pregnant women. The reason for repurposing the data was to conduct a supplementary analysis of the dataset, focusing on the issue of the acceptability or rejection of wearable technology within a prenatal care setting. This aspect was not the primary focus of the original research, providing an opportunity to explore the original data from a different angle (Heaton, 2004). Another rationale was that the data available was rich, detailed and in depth with the research question in this study (Sharp & Munly, 2022). Secondary analysis of data was also used because it was more economical, as opposed to the primary data collection processes, such as recruiting participants, conducting interviews, transcribing data, and analyzing findings, which would have been time-consuming and needed more resources (Heaton, 2008). By utilizing existing data, it allowed the researcher to focus on the analysis and interpretation of the data rather than on data collection logistics (Heaton, 2008; Sharp & Munly, 2022). Moreover, saving the costs that this thesis researcher would have incurred to collect the data themselves while it was already available in the university's data base (Heaton, 2008). Besides, the researcher also considered the ethical considerations associated with conducting research involving human participants, including issues related to informed consent, confidentiality, and participant burden. By using existing data, this study lessened the burden on pregnant women in Finland by respecting their privacy and confidentiality. According to research, the fertility rate in Finnish women has been gradually declining since 1987, moreover, in comparison to Nordic countries, Finland has the lowest total fertility rate (Nordic Perinatal Statistics, 2022; Roustaei et al., 2019). Additionally, the original study obtained appropriate ethical approvals and consent from participants, thus conducting a secondary analysis was considered to be a more ethically sound approach than collecting new data, as it avoided the need to re-approach participants for consent. (Heaton Janet, 2004; Sharp & Munly, 2022)

Last but not least, this study was structured as a cross-sectional analysis, utilizing secondary data to explore how pregnant women perceive wearable technology during pregnancy. The primary objective was to analyze existing data to understand trends and correlations without engaging in longitudinal follow-up.

7. Ethical Considerations

The ethics committee of the Hospital District of Southwest Finland granted ethical approval before the study commenced (approval ID: ETMK Dnro: 1/1801/2020). Approval was also btained from the health care clinics in which the data was collected. Pregnant women informed consent before participation in the study. This study adhered to ethical guidelines for research involving human participants as outlined by the Finnish National Board on Research Integrity (TENK, 2019) and follows the principles of informed consent, confidentiality, and voluntary participation.

The participation in the study was voluntary and those who participated gave informed consent in writing, and the consent was documented. The participants also had a right to withdraw from the study at any time without facing any negative consequences. As the participants were being recruited, they received information about the content of the research. Finally, because the pregnant women were recruited by the public health nurses at the clinic, they were made aware of their participation in the research study and were given all the information involving the research. (TENK, 2019). In publishing the results of the study, care has been taken to ensure that individual persons cannot be identified from it. Additionally, the interview data used in this research is securely stored in password-protected electronic files to prevent unauthorized access in accordance with data protection regulations and will be deleted after the end of this study thesis.(TENK, 2019).Overall, this thesis was conducted with careful consideration of ethical principles to ensure the protection of participants' rights and wellbeing. The thesis aims to respect the integrity and credibility of the research findings while respecting the autonomy and dignity of the pregnant women who participated in this study. Lastly, strict adherence to privacy and confidentiality protocols was maintained, ensuring that no additional contact with participants was not initiated post data collection.

8. Data collection

8.1 Study Participants and Setting

The study participants for this thesis are pregnant women at maternity clinics in Southern Finland. In these clinics, the pregnant women seeking antenatal care services can contact the health providers by phone call or email and also physically visit the antenatal clinics so as to receive these services. The recruitment of the potential participants was carried out by the public health nurses at the antenatal clinics after which the primary researcher approached the pregnant women by phone.

Participants in this study were selected using convinience sampling according to the need of care at the antenatal clinic between March and August 2020. Convenience During the recruitment process, some pregnant women declined to take part in the study (n=11), with reasons for refusal ranging from time constraints and language barriers to already using smartwatches or feeling that participation was unnecessary.

Suitable participants were pregnant women, over the age of 18 years, 13 weeks of pregnancy, the ability to use a smartphone, who had Finnish language skills and understanding of the English words.

The primary researcher conducted individual interviews with the pregnant women. These interviews, facilitated by the researcher, took place at the pregnant women homes and were audio recorded for subsequent analysis. The interviews varied in length, typically lasting between 30 minutes to 2 hours. The interview framework which can be found in the appendix, was designed based on the concept of patient engagement, allowing the pregnant women to openly discuss their experiences. The framework also provided space for detailed questioning by the primary researcher who was the interviewer. The interview themes revolved around the pregnant women's experiences with the guidance intervention (Öura ring), its impact on their well-being and stress management, factors affecting their well-being during the pregnancy period, and the strategies they employed for well-being and stress management. Additionally,

discussions covered the implementation of the guidance intervention (Öura ring) within the maternity clinic's services, its technical success, and suggestions for improvement.

8.2 Implementation of the intervention

The twenty pregnant women recruited for the study were utmost in their second trimesters from week 13 to 28 weeks, this was to allow for more than three visits at the clinic (THL, 2013). The study was clearly explained to the pregnant women, then the Öura smart ring was given to them to start using. The women were to wear the Öura ring for approximately ten weeks. The Öura ring application was not to be used or checked by the pregnant women during the first week, this one week was called the black week. This was so that the observer was not exposed to the intervention so that the data collected after the week could be compared with the data during the black week. The purpose was to examine whether the guidance intervention affected the behavior. The results of the black week are not reported in this thesis study. The women were not provided with access to their data during this time, the application was installed on their phones one week after they began participating in the study.

After the first week of using the Öura smart ring, the pregnant women received instructions and guidance on how to access the application and interpret the findings. Once they accessed the application, the women were encouraged to daily log in their sleep, physical activity, heart rate, and heart rate variability as they wished. Public health nurses gave training on using the device whenever the women had questions, and for technical issues such as battery or Bluetooth connectivity problems, the nurses at the prenatal care clinic and computer engineers offered troubleshooting support to ensure optimal use of the Öura ring device and application. The application usage continued until the end of the second trimester, marking the conclusion of the study's follow-up period. Additionally, the nurses at the prenatal care clinic were given Öura smart rings during the study to familiarize themselves with its features and usage.

Pregnant women were able to use the information provided by the smart ring throughout the study alongside the usual monitoring during pregnancy, except for the

first week that they had instruction not to use the Öura application. At the maternity care visit, the participant's information was reviewed together with the public health nurse via Öura's cloud service or smartphone application. At the end of the follow-up period, the researcher met the pregnant women again, interviewed them and collected the smart rings back.

9. Wearable technology Oura Smart Ring

The Öura ring is a personalized health device designed as a smart ring. It uses infrared light photoplethysmography (PPG) sensors to gather data on heart rate, heart rate variability, sleep, body temperature, and physical activity. Research has demonstrated the reliability of the Öura ring in self-monitoring these metrics (Alzueta et al., 2022). The collected data is analyzed to provide users with insights to improve stress management, sleep patterns, and activity levels. The Öura ring is paired with an application available for smartphones or computers, allowing users easy access to their data. With a fully charged battery lasting up to seven days under normal use, it ensures continuous health monitoring without the need for frequent recharging.
(Ōura Health Oy 4,2013).

9.1 Öura ring in measuring sleep

The Öura ring sleep score ranges from 0-100. It informs the user how well the user slept the previous night and what they can do to improve the sleep. If the score is 85 or higher, its termed as good sleep. If it's between 70-84 its termed as being on the right track, but if its below 70, then the data recommends some lifestyle changes that would help in getting better sleep. Seven aspects are considered when measuring the sleep quality, this includes the total period of sleep, efficiency of the sleep time, restfulness of the sleep, time taken to fall asleep, and the time the user goes to bed as it is measured according to the body's natural rhythm. Each of these elements can be a strength or an area for improvement in the user's sleep.(Ōura Health Oy 1, 2023; Henriksen et al., 2022)

9.2 Öura ring in measuring temperature

The Öura ring has also a temperature sensor built into it. The sensor measures temperature by minute. Measuring temperature throughout the day gives the full picture of how the body temperature varies throughout the day as opposed to measuring temperature with a thermometer and getting a snapshot of the reading. Secondly, the Öura ring measures the temperature on the skin since the body is very efficient with maintaining the deep core temperature stable. On the other hand, the skin temperature fluctuates a lot during the day and thus important as the body adjusts its temperature control based on certain aspects like if the user is asleep, awake, healthy or sick etc. (Ōura Health Oy, 2023; Alzueta et al., 2022)

9.3. Öura ring in measuring activity score

The Öura smart ring activity score also ranges from 0-100, the data from using the ring helps the user understand whether they are having the right balance between activity, inactivity and rest. If the metrics show 85 or higher, then it is a sign of optimal balance, 70-84, it is a sign of being in the right track, then lastly under 70, the balance between activity and rest is off and there would be need for change in ones' lifestyle in order to improve the balance (Ōura Health Oy 3, 2023). The activity score is determined by six daily Activity Contributors, which encompass inactivity, activity amount, and recovery factors. These contributors help assess if one is avoiding a sedentary lifestyle, meeting daily activity goals, exercising regularly, and allowing time for recovery. Öura ring tracks physical activity using a sensitive accelerometer and considers individual profile information, offering personalized activity goals and monitoring overall activity levels thus improving one's overall well-being (Ōura Health Oy 3, 2023; Henriksen et al., 2022).

9.4 Öura ring measuring Heart Rate Variability (HRV)

Heart Rate Variability (HRV) indicates various aspects of health and well-being, HRV measures the heart rhythm and how it varies between each beat. By monitoring HRV, the Öura Ring can provide knowledge into your body's stress levels and its ability to

recover from stressors. Higher HRV score, is linked to being relaxed and healthy, while lower HRV can be a sign of stress or illness. HRV also reflects the body's adaptability to different situations. A higher HRV indicates that the heart can respond flexibly to different situations, while a lower HRV can be a sign of a less adaptive autonomic nervous system. By tracking changes in HRV, the Öura Ring helps to understand how the body responds to lifestyle factors, allowing one to make informed decisions about the health.(Ōura Health Oy 2, 2023)

9.6 Öura ring readiness score

The readiness score informs the user on how ready the body is for the day ahead. The score also ranges from 0 to 100 and it gives scores on whether one is ready for challenges of the day, need rest and recovery time, or is it average. The readiness score considers the recent activity, sleep patterns and direct signals from the body such as the resting heart rate, heart rate variability and body temperature (Ōura Health Oy 3, 2023). It generally helps the user in knowing when the body is under stress or performing normally. The score is divided into seven daily contributors, e.g., daily activities, sleep, stress, and all these factors contribute to understanding what the cause of the low or high readiness score for the day would be Example, it considers the sleep for the previous night compared to the usual sleep quality, whether one has gotten enough sleep over a certain period of time, it considers activity levels from the day before, how much physical stress is the body under, any changes in the heart rate, HRV, body temperature and the hours of recovery sleep done. A high readiness score then confirms that one is ready to face the day, a ‘good’ range shows good enough recovery while a lower score invites the user to pay attention to the contributors as the body might not be fully recovered thus not ready to face the day. However, the readiness score is also not a one-day measurement, it’s more of looking at the health over time thus helping tool for improving the contributor factors to improving the overall well-being (Ōura Health Oy 3, 2023)

10. Data Analysis

10.1 Researcher's Reflexivity

In this research thesis exploring the factors that support or hinder the acceptance of wearable technologies in prenatal care, the researcher reflects on own experiences that influenced this study. Reflexivity involves acknowledging and expressing how the researcher's personal context, perspectives and experiences have shaped the research process and outcomes. (Olmos-Vega et al., 2023) At the outset of this research, the researcher was in the early stages of own pregnancy. This significant personal milestone enhanced the interest in the topic of prenatal care and wearable technology. The researcher's experience with pregnancy brought personal understanding of the physical, emotional and informational needs of pregnant women. This personal experience informed the researcher's perspective on the potential benefits and challenges of integrating wearable devices in to prenatal care settings. Additionally, the rearcher was using a wearable technology wrist watch to monitor health during the pregnancy. The direct interaction with the technology allowed for the experience in its functionalities and limitations which in turn influenced the curiosity to explore this study topic.

The researcher's personal experiences shaped several aspects of the research design, particularly the focus on understanding user experiences and acceptance of wearable technology in prenatal care. The researcher was interested in the practical aspects of using these devices, such as ease of use, relevance of the data provided, and the impact on the overall prenatal care experience. (Olmos-Vega et al., 2023)
As a pregnant researcher using wearable technology, there was firsthand perspective that allowed me to empathize on a deeper level with the participants. This empathy influenced the way the researcher interpreted the interview data, by ensuring that the voices and experiences of the pregnant women were central to the research findings. (Olmos-Vega et al., 2023)

10.2 Analysis of the data

In this thesis research, the data was analyzed using thematic analysis to understand the factors influencing the acceptance or and rejection of wearable technology integration in prenatal care (Braun et al. 2006). While the Unified Theory of Acceptance and Use of Technology (UTAUT) was not employed during the interviews with pregnant women, it was integrated into the analysis to provide a structured deductive framework for interpretation. The basis of the deductive data analysis was the Unified Theory of Acceptance and Use of Technology (UTAUT) model framework, which consisted of four key constructs. These constructs include performance expectancy, effort expectancy, social influence and facilitating conditions (Venkatesh et al. 2003). These key constructs formed the upper categories of the analysis. Subcategories were formed under the upper categories according to the material. Finally, the results of the analysis were compiled into a coherent report.

Thematic analysis helped in familiarizing with the data and to gain knowledge of the overall picture. The transcripts from the interviews with the pregnant women were then imported to NVivo software to facilitate the coding process. The data was then systematically reviewed and were analyzed using deductive thematic analysis. The analysis started with familiarization with the material, where the material was read through, and an overall understanding of the material was formed. In this study, the unit of analysis means different interviews, from which meaning units were defined in the analysis phase. The units of meaning are in terms of the purpose of the research and the research questions essential words and sentences, which the aim is to identify from the material as accurately as possible. In addition, the material was coded and interpreted, i.e. the reduced expressions were coded and classified into upper and lower categories according to the analysis of the deductive framework. The Nvivo program was used for inductive content coding and classification.

11. Research results.

11.1 Description of the participants

Twenty pregnant women who started the study (n=20) completed the guidance intervention until the end and participated in the interview conducted after the study, i.e. none of the participants dropped out. The average age of the pregnant women was 31 years, and the average duration of pregnancy at the start of the study was 15 weeks and 4 days.

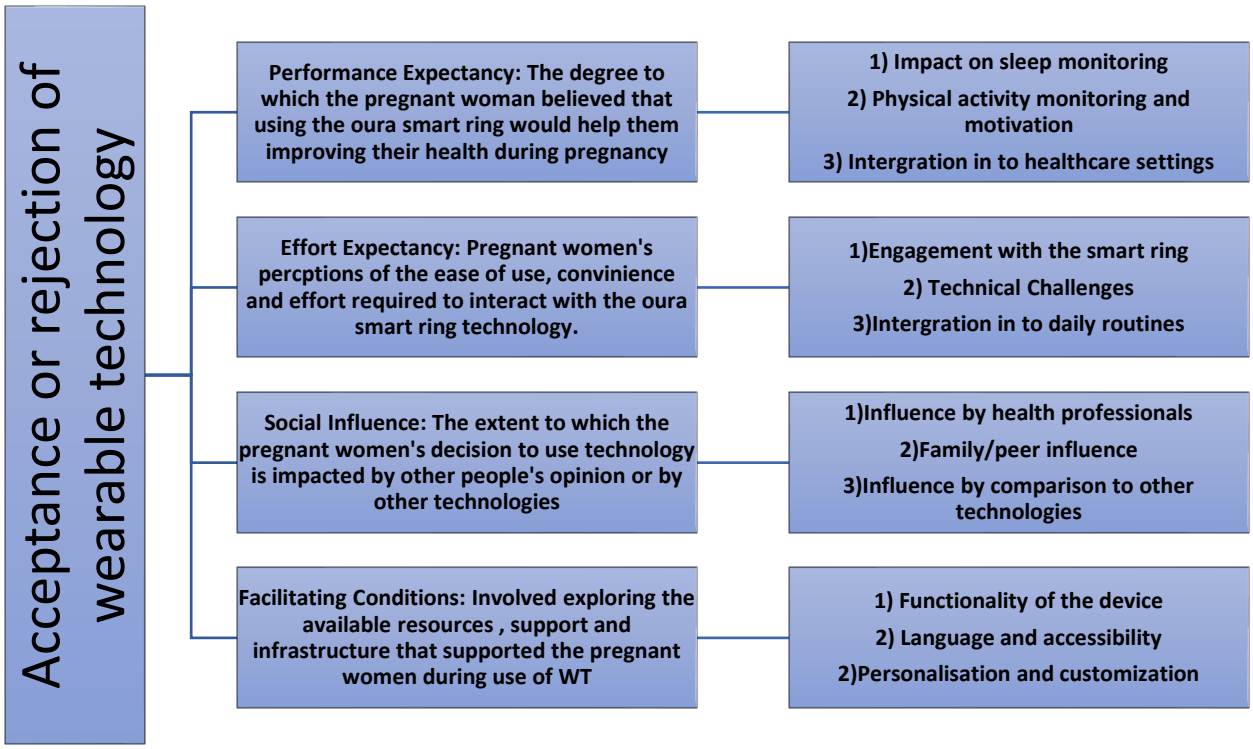
Table 2. Pregnant women's background information

IDs	Age	Level of education
ID1	34	Secondary school
ID2	28	College
ID3	33	College
ID4	33	College
ID5	32	Vocational school
ID6	33	College
ID7	31	Vocational school
ID8	29	Vocational School
ID9	32	Vocational School
ID10	33	College
ID11	31	Secondary
ID12	32	College
ID13	30	University
ID14	27	Vocational School
ID15	34	Vocational School
ID16	37	University
ID17	26	Vocational School
ID18	28	College
ID19	28	College
ID20	30	College

11.2 Acceptance or rejection of wearable device during pregnancy

The qualitative interviews offered a deeper understanding of factors that contributed to pregnant women's acceptance or rejection of wearable device integration during their pregnancy journey and care. In the analysis of the data, the pregnant individuals express their experiences with the Öura ring and how they themselves and the public health nurses engage with the data generated by these devices during prenatal appointments. The discussions between the pregnant women and public health nurses reveal insights into the perceived benefits, challenges, and implications of incorporating wearable technology like the Öura ring into prenatal care. Through deductive thematic analysis of interview transcripts, patterns of performance expectancy, effort expectancy, social influence and facilitating conditions emerge, highlighting the diverse range of factors that influence pregnant individuals' attitudes and behaviors.

Table 2. Acceptance or rejection of wearable technology: The table shows the themes and subthemes.



11.2.1 Performance expectancy

In this thesis, the pregnant women's view on performance expectancy involved the degree to which the Öura ring impacted their sleep monitoring, influenced their level of physical activity and how they perceived usefulness of wearable technology being integrated to the prenatal care visit. According to the pregnant women, one key role of the Öura ring was in facilitating sleep management. The pregnant women highlighted how the ring gave them understanding into their sleep patterns, such as duration of sleep, efficiency, and stages of sleep like REM (rapid eye movement) sleep. They also voiced on how the Öura ring feature of suggesting optimal bedtime routines positively impacted their sleep patterns. For instance, some participants noted that the device's reminders to adhere to a consistent sleep schedule helped in avoiding late-night activities, thereby enhancing overall sleep quality. The smart ring gave them information about their own sleep and the reason for their fatigue, for example due to night awakenings, too little sleep, or poorer sleep quality after the night shift at work for example. The pregnant women described taking a nap or investing in a good night's sleep the next night after a bad night's sleep.

The pregnant women expressed that using the Öura Ring gave them permission to rest, as it provided feedback about their fatigue levels, encouraging them to take breaks from household chores or work. The Öura ring also helped them recognize the impact of late-night meals on sleep and encouraged them to avoid heavy meals before bedtime.

The Öura Ring also served as a motivating tool, emphasizing the importance of prioritizing, and improving sleep habits by suggesting bedtime routines and reminding them to maintain a consistent sleep schedule. Through daily feedback and personalized recommendations, the Öura Ring encouraged the pregnant women to adopt healthier sleep practices, leading to increased awareness of their sleep patterns and necessary adjustments to optimize sleep quality. Additionally, it prompted participants to consider their overall well-being and pay attention to factors influencing their health during pregnancy.

“And then it's somehow comforting when it tells me that now you might be a little tired, so take it easy...” - ID1

“Well, at least, um, at least with regards to sleeping, the ring has brought about this thing that, when it suggests those bedtimes and such a rhythm and such, maybe it's brought about a reminder for myself through that, so that then, it's easier, so that the evenings don't drag on.” - ID14

Another subtheme was the device's influence on physical activity monitoring and motivation. The pregnant women voiced on how the device's tracking feature encouraged them to engage in regular physical activity by setting activity targets and providing real-time feedback. They described how wearing the device influenced their daily routines and encouraged them to adopt healthier habits for example, some pregnant women mentioned that the Öura ring prompted them to incorporate more movement into their day, such as taking breaks from their desk work to walk for some minutes. This showed the impact the Öura ring had on the participants’ decision making towards physical activity. The behavioral change reflected the persuasive influence of the Öura ring in promoting a more active lifestyle. The pregnant women also appreciated the device's ability to track their physical activity levels automatically and provide feedback on their performance. By continuously monitoring the steps taken, active minutes, and calorie expenditure, the Öura Ring enabled the participants to assess their progress towards achieving their health and fitness goals. This in turn facilitated their self-monitoring, self-regulation and promoted self-awareness when it came to physical activities. The interview data also showed the pregnant women’s appreciation towards the Öura ring's ability to provide personalized data about physical activity patterns, such as step counts, intensity levels, and sleep-related metrics. This allowed them to track their progress over time and make informed decisions about their lifestyle habits. By offering comprehensive data on various aspects of physical activity, the öura Ring empowered pregnant women to take control of their health and well-being.

“And then, well, of course, I have been monitoring my activity in a way that, well, I don’t sit too much. I have a job where I sometimes have to sit for long periods, so I check to make sure I remember to get up, to get up occasionally and move around. And especially now at work, since I have been spending a lot of time in the office, I have been doing this thing where I’ve been walking up and down the stairs and then coming back to my workstation” – ID3.

Despite the overall positive feedback of the Öura ring's physical activity tracking capabilities, concerns regarding the device's accuracy and limitations were also raised by the participants. Some pregnant women questioned the reliability of the data provided by the Öura ring, particularly in situations where certain activities may not have been accurately captured like walking while pushing the stroller or knitting. This uncertainty potentially undermined the pregnant women’s confidence in the device and its ability to provide meaningful insights into their physical activity patterns. While some participants expressed satisfaction with its accuracy, others questioned its ability to precisely capture their movement. This discrepancy suggests that while some activities were accurately recorded, others, such as household chores, bike rides, walking with the stroller, may not have been adequately noted by the device.

Moreover, although most participants expressed that the Öura ring device served as a motivating factor by reminding them to stay active throughout the day, thus contributing to their overall well-being. Some participants had an opposite experience that the Oura ring served as a demotivating factor when it came to physical activity monitoring. Some pregnant women voiced that the Öura ring would set high expectation on the steps to take and not take note of their present condition – pregnancy -. This in turn demotivated them in doing the physical activities as they were constantly feeling they could not reach the set daily goals.

"Well, not really. When it comes to the exercise recommendations, for example, when I went for a walk with the stroller, it doesn't really recognize that, and activities in the

kitchen, it doesn't really recognize that either. So, it just kept showing me in red all the time that I haven't done anything at all." – ID1

The data revealed various perspectives and experiences regarding the use of the Öura Ring during antenatal care visit. One finding was the varying levels of engagement with the Öura ring data during antenatal care appointments. While some pregnant women reported actively discussing and analyzing their ring data with the public health nurses, others mentioned that the data was not thoroughly examined or even discussed during appointments.

The interviews also revealed that the pregnant women had mixed perceptions of the Öura ring's impact on their healthcare experiences. Some expressed positive sentiments, such as feeling empowered by monitoring their health metrics and appreciating the opportunity to discuss the data with their healthcare providers. On the other hand, others expressed reservations or indifference towards the utility of the Öura ring in their healthcare routines, citing limited engagement or awareness of its potential benefits.

“Well, it’s interesting. But since I had already looked at them so much myself, it was more like just explaining to the nurse what the data was. But of course, since I had been monitoring the data closely myself, I could always show the nights of poor sleep or good sleep from the application. But it was fun to look at the data together” – ID14.

The interviews also showed the role of public health nurses in facilitating the integration of wearable technology into prenatal care. The pregnant women noted instances where the nurses engaged with the Öura ring data, providing knowledge and recommendations based on the information collected. However, some participants mentioned that there were also times where there was minimal discussion or acknowledgment of the ring data during appointments, some felt that there was decreased awareness and training among the public health care nurses regarding the interpretation and integration of Öura ring data into antenatal care process.

The findings also showed the importance of individual factors, such as personal interest and engagement with technology, in shaping the adoption and utilization of the Öura Ring in healthcare settings. Participants who expressed enthusiasm for tracking their health values and engaging with the Oura ring data reported more positive experiences during healthcare appointments. While those who demonstrated limited interest or understanding of the technology exhibited lower levels of engagement and perceived utility.

“Well, it's always nice to hear the professional opinion because when you interpret things on your own, then again, it's about what the professionals think. For example, the REM sleep for me was such that neither of us could really say anything about it, but if they could, it would have been really interesting to know why it's so short.”- ID20

11.2.2 Effort Expectancy

The analysis revealed that pregnant women’s experiences varied in terms of effort expectancy, influenced by factors such as engagement with the smart ring, technical challenges, and integration into daily routines. One major factor that emerged was the initial interest and engagement with the smart ring's features, particularly regarding sleep tracking and activity monitoring. The pregnant women expressed enthusiasm about exploring the capabilities of the device, especially during the initial stages of use. Some felt that having the Öura ring gave motivation towards better general wellbeing. However, over time, some participants mentioned experiencing diminishing returns in terms of discovering new insights or benefits from the smart ring and the disappointment when certain aspects, such as activity tracking, did not meet expectations.

The Öura ring device having technical challenges was another concern among the pregnant women, these issues included difficulties with device pairing, inconsistent performance and issues with the software. The findings from the interviews showed various technical challenges encountered by participants while using the device. One

consistent issue reported by multiple participants was Bluetooth connectivity problems where the device sometimes struggled to maintain a stable connection, requiring them to restart it, which caused frustration and inconvenience while using the smart ring.

Charging and battery issues also emerged as significant concerns among participants, affecting the device's usability and reliability. Some participants reported difficulties in charging the device, and monitoring battery status, with some participants expressing frustration at the lack of accurate battery level indicators or notifications. This lack of visibility into battery status further complicated the pregnant women's ability to manage their device usage effectively. Slow charging times were shown to be source of inconvenience, the pregnant women reported having to wait extended periods for their devices to charge fully, which limited their ability to use the device when needed. Additionally, concerns were raised regarding data synchronization, with pregnant women encountering unexpected errors, crashes, or malfunctions while using the Öura ring, which resulted in disrupting their experience.

"…..And then there's also the Bluetooth, sometimes it gets all tangled up, you have to restart the device, and that takes time." – ID11

"…..And then you had to fiddle with the ring a bit to get it to charge," – ID20

"And sometimes, even though you know you've checked it just before falling asleep in the evening, that it's connected, still in the morning there's no information, and the system is not responding to commands even though the ring is charged, and the phone is charged, but the nurse at the clinic explained that the system can be unresponsive sometimes" - ID16

"It started to glitch towards the end, and then in the last week, it stopped working altogether, so all sleep recordings were lost" – ID3

The analysis also showed the importance of integrating the Öura ring into the pregnant women's daily routines seamlessly. Some participants mentioned that they found it challenging to integrate the use of the device into their daily routines, often forgetting to wear or charge the device regularly. Some participants mentioned having to remove the ring often to wash their hands or use disinfectant to their hands, which caused some anxiety because they did not want to forget or misplace the ring. The effort expectancy was also influenced by factors such as the device's comfort, convenience, and integration with other technologies. There were varying degrees of satisfaction with the smart ring's design and form factor, which influenced their perception of effort expectancy. While some found the device comfortable and easy to wear, majority of the pregnant women struggled with its size or appearance. Some participants mention being embarrassed at the beginning of the use of ring, that they felt the aesthetic of the ring was more manly than womanlike, which did not support the notion of ease of use and integration to daily life.

"Well, maybe it's not aesthetically pleasing to me, and it's not very, it took me a long time to get used to it, because it's quite big"- (ID23)

Additionally, the integration of the Oura ring into other health monitoring devices presented additional challenges to some participants. Smooth integration with existing routines and activities can make it easier for pregnant women to incorporate device usage into their daily lives. For example, wearable devices that sync data with popular health and fitness apps or offer features such as reminders and notifications tailored to pregnancy-related milestones can help pregnant women stay motivated and engaged with the technology. In this study, some participants voiced that the Öura ring was unable to recognize some activities like riding the bicycle, and the participants themselves had to instead manually mark the activity in the application.

While the ring offered valuable insights into sleep quality, activity levels, and heart rate variability, some users found themselves burdened by the need to manage multiple devices with different charging and syncing requirements.

11.2.3 Social Influence

In the analysis of the data, the influence of social factors influencing pregnant women's acceptance or rejection of wearable device use during the pregnancy journey is shown in several ways. The interviews expound on various dimensions of social influence, as perceived and experienced by the pregnant women. These dimensions include influence by health professionals, family/peers, and technologies.

In this research, the public health nurses played a role in shaping pregnant women's perceptions of wearable device integration during the pregnancy journey. Most of the pregnant women often expressed they appreciated recommendations and guidance provided by public health nurses regarding the use of Öura ring data during the antenatal visit. They mentioned that despite the excitement of self-monitoring, professional guidance and opinion was always meaningful. Another aspect formed from the findings is the pregnant woman's acknowledgment of the public health nurse`s influence on their perception and interpretation of the ring data. Some participants express how discussions with the public health nurses shaped their understanding of the data and influenced their attitudes towards the wearable technology.

"I noticed right away that it started to affect my day because I always opened the application first thing in the morning and checked how I had slept, so then it talked about it at the maternity clinic, so she said, 'Don't look at it in the morning,' so then it passed." – ID6

The pregnant women also described about sharing their Öura ring data with the public health nurses during prenatal appointments. While some expressed initial apprehension or uncertainty about the relevance of the data, some found importance of the information provided by the public health nurses based on the Öura ring data. Less than half of the pregnant women stated that, discussions about sleep patterns, activity levels, or physiological parameters observed through the smart ring data was interesting and some pregnant women even gained ideas on potential areas for

improvement. The engagement with public health nurses fostered a sense of collaboration and trust, with pregnant women appreciating the personalized feedback and recommendations tailored to their specific health needs and circumstances.

On the other hand, majority participants expressed mixed feelings about the influence of the public health nurses when it came to the data from the Öura ring. Initially, it was acknowledged that there were positive aspects of discussing the data with the public health nurses, they found it interesting and possibly helpful. However, there were also indications of some skepticism or disappointment in the depth of knowledge or engagement of the public health nurses with the data. For example, some participants mentioned that the public health nurses did not seem to delve deeply into the data or provide additional information, leaving them wanting more expertise or guidance in interpreting the information.

"…Well, it's always nice to hear the professional opinion because when you interpret things on your own, then again, it's about what the professionals think……..." – ID20

Exploring family or peer influence involved understanding how the two factors influenced the pregnant individual's perspective on accepting to use the smart ring. The influence manifested itself is several ways, including opinions, concerns and shared experiences related to the oura ring use, its features, benefits, and barriers. Some participants mention having family members who expressed curiosity in ring technology after seeing it in use wanted to invest in getting the smart ring for own use. While some participants described how friends and family members were curious about the device, leading to discussions about its features and benefits. Some participants mentioned having had discussions about Öura ring data with their partners. One participant described how her husband attempted to use the smart ring but struggled to set it up, leading her to question its usability.

“Well, men seem to have more of these apparently now because there's always talk about it when they see it. So, my own dad is planning to get one now because he saw how it works with me.” – ID6

“This has been quite interesting. Many have asked, 'Is that the Oura ring?' They already knew what it was, so in that way, for me, well, I knew there were smart rings, but then again, not this one exactly, so many have been like, 'I want to see what it shows.' They've been interested, for sure, so I've always opened it.” - ID15

The public health nurses contributed to peer influence as well, for example, some participants recalled enjoying to discuss with the public health nurse’s experiences with using the oura ring , as well as their own experiences and comparing notes.

"It was nice that the nurse herself had been using the ring, so then we could share our experiences maybe better." – ID14

When it came to influence by comparison of other technologies, some participants compared the Öura Ring with other wearable devices like wristbands or smartwatches. These comparisons provided valuable insights into how users perceive the Öura ring in relation to existing technologies. Öura ring was perceived to be superior compared to traditional wristbands in terms of functionality and usefulness. However, it was also described as less aesthetically pleasing compared to other devices, concerns were raised about the size and visibility of the Öura Ring, majority of the participants voiced that it was a large ring particularly in comparison to smaller and less conspicuous wristbands or watches. To some participants, the larger size of the Öura ring may have been seen as cumbersome or obtrusive by potentially detracting from its overall appeal or wearability.

"I've had the wristband, so if I compare it to that, the wristband has been really useless." – ID11

11.2.4 Facilitating conditions

Facilitating conditions play a crucial role in shaping the overall user experience and determining the extent to which wearable technology can fulfill its intended purposes in supporting the pregnant individuals (Venkatesh et al., 2003b). The functionality of a wearable device refers to its ability to perform its intended tasks effectively and reliably (Venkatesh et al., 2003b). The pregnant women relied on the Oura smart ring to monitor various aspects of their health and pregnancy, such as activity levels, heart rate and sleep patterns. Therefore, the functionality of the device, including its accuracy, reliability, and ease of use, was important. Most of the pregnant women in general found the functionality of the Oura ring satisfactory, especially regarding sleep tracking and activity monitoring. All the participants appreciated the capability of self-monitoring of health metrics by using the smart ring, there was also satisfaction with the use of the mobile application. The majority of the participants did not use the cloud service as the phone application was readily available and more accessible.

"Well, I haven't used the cloud service. If that's the desktop version. Yeah, I haven't even looked at it at any point. But, well, the mobile app was quite, quite okay." – ID1

Then there was the accessibility of the data in an understandable language particularly in diverse and multicultural contexts. The language barrier was not a significant issue for most of the participants in this study. However, some expressed a preference for having the option to use the device and app in the mother tongue ie. Finnish. –The participants understood the Oura ring application while it was in English, though Finnish language was in a way better as some understood the information more clearly without much effort. Pregnant women from different linguistic and cultural backgrounds may encounter barriers in understanding device instructions or navigating the device interface if language support is limited. Therefore, ensuring multilingual support and accessible design features, such as intuitive navigation and clear instructions, can enhance the usability and inclusivity of wearable technology for pregnant women from various backgrounds (Noack et al., 2022).

“Well, of course, Finnish is nice in that way because then you understand exactly what's being said, even though I understood it in English as well.” -ID16

Personalization and customization were another facilitating condition that would have enhanced the usability, satisfaction and effectiveness of the Oura ring use for the pregnant women. The women highlighted that the Oura ring did not recognize their state of pregnancy thus recommended demanding physical activity measurements. Throughout the interviews, participants highlighted the diverse nature of their pregnancies, with varying health concerns, goals, and preferences. Some women emphasized the importance of monitoring specific health metrics like heart rate or sleep patterns, while others prioritized tracking physical activity levels or stress management. By having customizable settings into wearable devices, such as the ability to set personalized health goals or adjust notification preferences, the pregnant women can tailor their experience to align with their individual needs and preferences.

12. Discussion

12.1 Performance Expectancy

In both the literature review and the interview analysis there is significance of perceived usefulness and personal experiences in influencing the acceptance and integration of wearable technology in prenatal care. In this thesis study, the literature review constructs a theoretical framework that demonstrates a positive correlation between perceived usefulness and the acceptance of wearable devices. Conversely, the interview analysis offers practical insights gathered from pregnant women's experiences with the Öura Ring. The reviewed studies, consistently demonstrate that pregnant women are more likely to accept and utilize wearable devices if they perceive them as beneficial to their health outcomes. Factors such as monitoring physical activity, managing gestational diabetes, and receiving personalized health advice are demonstrated as crucial contributors to perceived usefulness(Jimah et al., 2021a; Koech et al., 2022). The interview analysis corroborates the findings from the literature review by showing the pregnant women's perceptions of the Oura Ring's usefulness.

The pregnant women expressed positive views regarding the ~~o~~Oura ring's impact on sleep management, physical activity, readiness level and the general wellbeing. However, some participants raised concerns about the accuracy of physical activity monitoring and the suitability of activity goals, indicating that the pregnant women understood the device's usefulness.

The studies reviewed also provide evidence of the potential benefits of integrating wearable technology into healthcare settings, particularly within the context of antenatal care (Penders et al., 2015). The studies suggest that wearable devices can enhance monitoring, facilitate communication between patients and healthcare providers, and empower individuals to take control of their health (Kominiarek et al., 2019; Leonard et al., 2023; Thomas et al., 2022). On the other hand, the pregnant women interviews described varying levels of engagement with the Oura Ring data during antenatal care appointments. While some participants reported positive experiences discussing and analyzing their ring data with the public health nurses, others expressed reservations or indifference towards the device's utility in healthcare routines. The role of healthcare providers in facilitating the integration of wearable technology was also highlighted, with varying levels of engagement observed among the public health nurses.

Moreover, the literature review acknowledges the role of individual factors, such as personal interest and engagement with technology, in shaping the acceptance and utilization of wearable devices(Jimah et al., 2021; Leonard et al., 2023) . Studies suggest that individuals who are enthusiastic about tracking their health metrics and engaging with wearable technology are more likely to perceive it as useful and beneficial (Jimah et al., 2021). The interview analysis reinforces the importance of individual factors in determining pregnant women's experiences with the Oura Ring. Pregnant women who demonstrated enthusiasm for tracking their health values reported more positive experiences, while those with limited interest or understanding of the technology showed lower levels of engagement and perceived utility.

12.2 Effort Expectancy

Effort expectancy plays a significant role in determining users' perceptions of the ease of use, convenience, and effort required to interact with wearable technology (Venkatesh et al., 2003). In the literature review, various indicators of effort expectancy were identified through participant feedback and usage patterns. For example, participants in the study on technology-based pregnancy and wellness intervention generally found the Two Happy Hearts (THH) mobile app and smart ring to be user-friendly and easy to use (Jimah et al., 2021) . High engagement levels with the wearable technology components, such as wearing the smart ring and completing app-based surveys, indicated that users did not perceive the technology as overly burdensome or difficult to use. Additionally, positive feedback on the user interfaces of the wearable devices, as seen in the satisfaction with the Fitbit website and smartphone app, further supported the notion of ease of use (Jimah et al., 2021; Leonard et al., 2023).

However, not all participants experienced the same level of ease with the technology. Technical issues, such as problems with Bluetooth connectivity and synchronizing devices, were reported by some users, leading to challenges in interacting with the technology. These issues contributed to a deeper understanding of effort expectancy, highlighting the importance of addressing usability issues to improve user experience and acceptance (Grym et al., 2019; Leonard et al., 2023; Thomas et al., 2022).

In this research thesis, pregnant womens' perceptions of effort expectancy were also influenced by factors such as functionality, technical issues, and integration into daily routines. Initial engagement with the smart ring's features, particularly sleep tracking and activity monitoring, was high among participants, demonstrating a level of interest and enthusiasm. However, over time, users experienced diminishing returns as the device failed to provide insights accommodating their journey of pregnancy or benefits beyond the initial engagement period.

Technical issues and usability challenges, such as malfunctions and synchronization issues, also affected the pregnant women’s perceptions of effort expectancy, adding to

the perceived effort required to maintain and interact with the device. Additionally, subjective evaluations of the device's design and comfort played a significant role in users' overall experience and perceived effort expectancy, with some participants expressing dissatisfaction with the size or appearance of the smart ring.

Overall, the findings from both literature and interviews emphasize the importance of addressing usability issues and enhancing the seamless integration of wearable technologies into pregnant women's' daily lives to improve acceptance and long-term engagement. By understanding the pregnant women's' perceptions of effort expectancy and addressing their concerns, developers and healthcare providers can design more user-friendly and effective technologies for prenatal care (Grym et al., 2019).

12.3 Social Influence

The combination of the literature review and analysis of interview results provides a comprehensive understanding of the influence of peer groups, healthcare providers, and other social factors on pregnant women's attitudes towards wearable technology, with a specific focus on the Oura Ring.

Both the literature review and interview analysis show the important role of healthcare professionals in shaping pregnant women's acceptance or hindrance of wearable technology. Findings from various studies highlight that recommendations from healthcare providers are pivotal in promoting acceptance among pregnant women (Kominiarek et al., 2019; Schramm et al., 2019). The studies showed that the participants were more likely influenced by healthcare professionals who may have recommended the use of these devices for prenatal care. Trust in healthcare professionals is one of the determinants, with positive experiences leading to peer recommendations, further enhancing acceptance within social circles (Ehrlich et al., 2021). The interviews further explore the influence of public health nurses, with participants valuing their recommendations and guidance regarding the interpretation of Oura Ring data. However, there were mixed sentiments regarding the depth of

knowledge and engagement of healthcare professionals, indicating a need for more comprehensive support in utilizing wearable technology effectively.

Family and peer influence also emerged as another factor shaping attitudes towards the Oura ring. Familial support and endorsement positively influenced decision-making, with curiosity about the device leading to potential adoption among family members. Peer interest sparked discussions and shared experiences, contributing to the overall perception of the technology. Additionally, validation from public health nurses' own experiences with the Oura Ring further reinforced its acceptance within social circles. The literature review supports these findings, highlighting the role of peer influence in promoting technology acceptance among pregnant women (Kominiarek et al., 2019; Leonard et al., 2023). For example, the study by (Kominiarek et al., 2019) found that a high percentage of participants (88.9%) reported that they would recommend the wearable technology to a pregnant friend. And also (Thomas et al., 2022)study highlighted that the participants themselves played a role in social influence. When asked about their experiences, a significant percentage of participants reported that they would recommend the intervention, including the wearable technology, to other pregnant patients. This recommendation shows the influence of peers and social connections in promoting the acceptance of wearable technology. When pregnant individuals had positive experiences with the technology, they were more likely to influence others to adopt it.

In the interviews, the pregnant women described comparing the Oura ring to other wearable technologies that they had used before or were using, these comparisons of the Oura Ring with other wearable devices provided insights into perceived advantages and drawbacks. The Oura Ring was favored for its functionality and aesthetics compared to traditional wristbands or smartwatches. However, concerns were raised about its size and visibility, potentially acting as barriers to adoption. While in the literature review, the studies did not mention any participants that had done comparisons with any of the wearable technologies. However, these findings form the

interviews emphasize the importance of considering user preferences and design features in promoting technology acceptance.

These results put emphasis on the multifaceted nature of social influence on pregnant women's acceptance of wearable technology. Healthcare professionals, family members, peers, and comparisons with other technologies all play pivotal roles in shaping attitudes and preferences (Ehrlich et al., 2021b; Jimah et al., 2021a). Understanding these influences is important for the successful integration and adoption of wearable technology in prenatal care settings. Lastly, the findings highlight the importance of tailored support and guidance from healthcare professionals to address potential barriers and promote effective utilization of wearable technology for maternal health monitoring (Ehrlich et al., 2021; Grym et al., 2019; Kominiarek et al., 2019).

12.4 Facilitating Conditions

The review of the studies in this research, explored the facilitating conditions, highlighting the importance of factors such as health coaching support, technical infrastructure, and adequate training. For instance, one study emphasized the role of health coaching support and remote sessions in creating a facilitating environment for participants to comfortably engage with wearable devices (Whitaker et al., 2022). In the interviews as well, some participants complained of not knowing which application to download as they did not understand the training at the beginning of the study. This shows the significance of human support training in facilitating the acceptance of technology. Additionally, another study stressed the importance of reliable internet connectivity and technical assistance, indicating the critical role of infrastructure in ensuring seamless integration and effective use of wearable technology (Sarhaddi et al., 2021). These findings collectively emphasize the multifaceted nature of facilitating conditions and their impact on technology acceptance in pregnancy care.

The analysis of interview results provided further validation of the facilitating conditions identified in the literature review. Participants' experiences with the Öura ring highlighted the importance of device functionality, accessibility, integration with daily

activities, and personalization features. For example, participants expressed satisfaction with the functionality of the Öura ring for sleep tracking and activity monitoring. However, technical issues such as Bluetooth connectivity problems and device compatibility issues were reported, indicating the importance of device reliability and performance. Additionally, concerns were raised regarding multilingual support and intuitive navigation, with some participants expressing a preference for using the device and app in their native language. These findings show the significance of accessibility and language support in ensuring inclusivity and usability for pregnant women from diverse backgrounds.

Lastly, participants from both the studies and the interviews voiced the importance of smooth integration with daily activities to enhance the usability and effectiveness of wearable technology (Ehrlich et al., 2021; Grym et al., 2019; Sarhaddi et al., 2021). Issues such as the device's inability to recognize certain activities like walking / riding the bicycle or even recognize they were pregnant and data synchronization problems were reported, emphasizing the need for seamless integration with existing routines. Additionally, personalization and customization features were deemed essential by participants, with suggestions for improvements in customization options to enhance user experience and satisfaction. These findings show the importance of addressing facilitating conditions such as device functionality, accessibility, integration with daily activities, and personalization features to promote the acceptance and adoption of wearable technology in pregnancy care.

The findings from the literature review and analysis of interview results highlights the critical role of facilitating conditions in shaping the acceptance and integration of wearable technology in pregnancy care. By addressing key facilitating conditions such as technical support, accessibility, customization and personalization features, developers and healthcare providers can enhance the usability and effectiveness of wearable technology, ultimately improving maternal health outcomes.(Venkatesh et al., 2003)

13. Impact on healthcare

This study impacts prenatal care procedures in several ways that could potentially improve the quality of prenatal care and maternal health outcomes. Firstly, enhanced patient engagement, by understanding the factors influencing pregnant women's acceptance and or barriers of wearable device integration, health care providers can customize their approach to engage the pregnant women more effectively. This would include offering adequate support for technical issues, highlighting potential benefits of using wearable technology for monitoring health during pregnancy. Which in turn the pregnant women would be more active in participating in their care, leading to better health outcomes for both mother and baby. There is also the potential for improved monitoring and management brought by wearable device integration to prenatal care. Thus, the healthcare providers can gain valuable information into the state of the patient's health between appointments. This would allow for early detection of potential complications and timely interventions, reducing the risk of adverse outcomes during pregnancy. The findidngs from this thesis study also highlights the need for education and training to healthcare practioners when it comes to wearable technologies. Thus for the healthcare practioners to be able to endorse these technologies, there needs to be policies in place to support their trainings and education in the use of wearables. The findings in this thesis can also contribute to future research and innovation in the field of wearable technology and prenatal care. By identifying areas of improvement, such as solving technical glitches and enhancing user experience, researchers and developers can design and implement technologies that better meet the needs of pregnant women and healthcare providers

14. Trustworthiness of the study

Trustworthiness in qualitative research encompasses the credibility, dependability, confirmability, and transferability of the study's results. For this study, the trustworthiness of the findings will be assessed based on the criteria established by Lincoln and Guba (Lincoln, 1985). The thesis and its reporting have been described as

precisely as possible, so that it would be easier for the reader to follow the decisions made in the different stages of the thesis, and to illustrate this, a description of the analysis body has been presented in the appendix frame (Lincoln, 1985).

To ensure credibility, several measures were considered during the data collection and analysis process. Firstly, the studies included in the literature review were identified and measured for credibility using the Joanna Briggs Institute (JBI) tool to identify relevant studies (Moola et al., 2015; Tufanaru C, Munn Z, Aromataris E, Campbell J, 2017). Then the data was perused in totality multiple times before writing the findings. In the analysis of qualitative data, the interpretations of the findings covered the entire data set. The data was read multiple times to understand the data, then was analyzed into themes and subthemes.(Braun & Clarke, 2006; Nowell et al., 2017) With the help of the theoretical framework, the researcher can describe the analysis process which makes it easier for the reader to understand how the results of the thesis have been achieved (Braun & Clarke, 2006).

Secondly, triangulation was utilized by cross referencing the data to enhance the credibility of the findings(Lincoln, 1985). Although direct interaction with participants was not feasible due to the use of secondary data, efforts were made to validate the interpretation of the data through the supervisor who was the leader on the project when the primary data was being collected (Nowell et al., 2017). This thesis has been carried out with accuracy and care. Appropriate methods have been used to collect the data. In the analysis and reporting of the data, direct quotations from the sample population have been used in order to preserve the original meaning(Braun & Clarke, 2006a). Efforts have been made to avoid a loss of credibility by using the original expressions accurately and by systematically combining similar expressions under different categories.(Braun & Clarke, 2006; Nowell et al., 2017) To facilitate the processing and analysis of the data, the electronic program NVivo was applied.

To enhance transferability in this thesis, detailed descriptions of the research context, participants, and data analysis procedures were provided to facilitate the transferability

of the findings to similar settings or populations. With the help of the appendix frame, the researcher can describe the analysis process, which makes it easier for the reader to understand how the results of the thesis have been achieved as the validity and reliability is also affected by the consistent and truthful reporting of the results, and so that the reader can follow the conclusions made by the researcher (Braun & Clarke, 2006; Lincoln, 1985). However, it is essential to recognize that the transferability of qualitative research findings is inherently context-dependent, and readers are encouraged to consider the unique characteristics of their own settings when interpreting the results (Lincoln, 1985).

Dependability, which refers to the reliability and consistency of the findings, was ensured through rigorous documentation and guidance from my supervisor (Lincoln, 1985). A learning diary was maintained, documenting the research process from data collection to analysis, to ensure dependability. Check-in discussions with my supervisors were also conducted to review and refine the research process, thereby enhancing the reliability of the study findings.

Finally, confirmability, the extent to which the findings are shaped by the data rather than the researcher's biases or preferences (Lincoln, 1985), was addressed through reflexivity and external audit. Being aware of the position of a researcher and an expectant mother, several steps were taken to mitigate potential bias. The researcher questioned their own attitude, the process of thought, own values and assumptions regarding their own biases and perspectives were emphasized to enhance confirmability. Additionally, supervisors with expertise in qualitative research methods were invited to review the research process and findings, providing additional validation.

In this thesis study, secondary data from the interviews with twenty pregnant women was used,even though there was rich data available, a limitation that came from that, was the luck of control over the data collection process. Thus the researcher on this study had limited influence on the quality and depth of the data available. While the

secondary data provided knowledge into the factors that influence acceptance and rejection of wearable device, there may be aspects of the phenomenon that may not have been fully explored due to limitations of the available data. Another limitation is that the technology in this day and age changes very fast, the data used for this thesis was collected in the year 2020, with the Öura ring generation2, thus the data analyzed may not fully capture the present state as Öura ring already evolved to generation 3. The study also included a small sample size, however, the data provided was rich and meaningful to the topic.

15. Conclusion

This thesis findings have shown that there is potential in increasing adoption of wearable technologies with pregnant women and integrating the wearable technology into prenatal care settings. The pregnant women voiced that the use of the Öura ring as an intervention was a positive experience, it was evident that they had positive perception to its usefulness and ease of use despite the technical glitches

Moreover, there were mixed views on the pregnant women's experiences during their visits to the prenatal clinic and the role of the public health nurses in facilitating the integration of smart ring data into their care. Despite a few women having enjoyed reviewing the data with the public health nurses, majority of the women reported that there was luck of added value, they expressed disappointment in the depth of knowledge or engagement of the public health nurses with the Öura ring data.

Overall, understanding the factors influencing acceptance and rejection of wearable device integration in prenatal care is important to utilize the full potential use of wearables to improve pregnancy outcomes. Perceived usefulness, effort expectancy, social influence, and facilitating conditions all played interconnected roles in shaping pregnant women's attitudes and behaviors towards wearable technology.

Addressing challenges such as technical issues, integration into daily routines, and doubt towards technology requires a multifaceted approach involving user-centered design, adequate support from healthcare providers, and developers. By leveraging the insights gained from this study, healthcare providers and policymakers can develop

strategies to enhance the acceptance and adoption of wearable technology in prenatal care, ultimately improving maternal health outcomes.

15.1 Potential improvements

In future studies, improvement to the research would involve purposive sampling of pregnant women or individuals who have previous experience of wearable technology for example, thus improving the variation of the sample as opposed to convenience sampling of the population in the study. Secondly, having the intervention wearable device and also a control group to measure the acceptance or rejection of wearable technology with pregnant women, different methods in the research like mixed method approach to measure both the feeling and the experiences.

15.2 Innvovative Aspect

This thesis study examines the phenomenon of the user experience and acceptance of wearable technology among pregnant women. While previous studies have primarily examined the technical functionalities of wearable devices, this research places emphasis on understanding the subjective perceptions, attitudes, and preferences of pregnant women towards these technologies. Through qualitative interviews and thematic analysis, this study explores the factors influencing pregnant women's decisions to accept or reject wearable device integration in prenatal care, thereby providing valuable knowledge for designing user-centered interventions and technologies. Another innovative aspect is that this study reflects on previous researched studies, technology acceptance theory and health informatics. Thus by considering different perspectives this study offers a comprehensive understanding of the complex interactions between technological, social, and healthcare factors shaping the adoption of wearable devices in prenatal care thus enriching the theoretical framework guiding research, improves the development of wearable technology and gives recommendations to health care providers.

15.2. Future recommendations

From the data researched in this thesis, the variation between perceived usefulness and actual experiences, particularly regarding physical activity monitoring and integration into healthcare settings, highlight the need for further research and intervention. Addressing concerns about device accuracy, devices custom made for pregnant women with modular design and flexibility to fit the fluctuations in e.g. finger size throughout pregnancy. Devices that automatically set realistic goals fit for pregnant women, and enhancing healthcare providers' awareness and engagement with wearable technology are essential steps in optimizing the use of wearables and improving pregnancy outcomes and also acceptance of these technologies among pregnant women.

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Appendix 1: Database search

Data base	Date of search	Search terms	Filters	results
PubMed	5.08.2023	("expectant mother*"[All Fields] OR "pregnan*"[All Fields]) AND ("maternal care*"[All Fields] OR "antepartum*"[All Fields] OR "prenatal*"[All Fields] OR "perinatal*"[All Fields] OR "antenatal*"[All Fields]) AND ("experience"[All Fields] OR "experience's"[All Fields] OR "experiences"[All Fields]) AND (("fitness trackers"[MeSH Terms] OR ("fitness"[All Fields] AND "trackers"[All Fields]) OR "fitness trackers"[All Fields] OR ("activity"[All Fields] AND "tracker"[All Fields]) OR "activity tracker"[All Fields]) AND ("biosensing techniques"[MeSH Terms] OR ("biosensing"[All Fields] AND "techniques"[All Fields]) OR "biosensing techniques"[All Fields] OR "biosensor"[All Fields] OR "biosensors"[All Fields] OR "biosensor s"[All Fields] OR "biosensoric"[All Fields] OR "biosensorics"[All Fields])) OR ("m health*"[All Fields] OR "ehealth*"[All Fields] OR "wearable*"[All Fields] OR "health tech*"[All Fields] OR "app"[Text Word] OR "apps*"[Text Word] OR "application*"[All Fields] OR "application program*"[All Fields] OR "Mobile Applications"[MeSH Terms] OR "Mobile Medical Apps"[Text Word] OR "fit bit*"[All Fields] OR "oura ring*"[All Fields] OR "smart watch*"[All Fields] OR "smartwatch*"[All Fields] OR "wearable computer*"[All Fields] OR "wearable device*"[All Fields] OR "smart band*"[All Fields] OR "iphone*"[All Fields] OR "smartphone*"[All Fields] OR "android*"[All Fields] OR "fitness track*"[All Fields] OR "activity track*"[All Fields] OR "facebook app*"[All Fields] OR "MyfitnessPal"[All Fields] OR "google fit"[All Fields]) AND ("accept"[All Fields] OR "acceptabilities"[All Fields] OR "acceptability"[All Fields] OR "acceptable"[All Fields] OR "acceptably"[All Fields] OR "acceptance"[All Fields] OR "acceptances"[All Fields] OR "acceptation"[All Fields] OR "accepted"[All Fields] OR "accepter"[All Fields] OR "accepters"[All Fields] OR "accepting"[All Fields] OR "accepts"[All Fields] OR "barriers"[All Fields] OR "rejection") AND ("technology"[MeSH Terms] OR "technology"[All Fields] OR "technologies"[All Fields] OR "technology s"[All Fields]) AND ("maternal care*"[All Fields] OR "antepartum*"[All Fields] OR "prenatal*"[All Fields] OR "perinatal*"[All Fields] OR "antenatal*"[All Fields])	Articles in English language	257
CINAHL	05.08.2023	TI (expectant mothers or pregnancy or pregnant or prenatal or antenatal or perinatal or maternal) AND ((handheld* OR mobile* OR pda[tw] OR "handheld PC*" OR "personal data assistant*" OR "Computers, Handheld"[Mesh] OR ipad* OR "tablet computer*" OR "tablet PC*" OR iphone* OR smartphone* OR "cell phone*" OR "cellular phone*" OR "mobile phone*" OR "mobile device*" OR wireless* OR mHealth* OR	English language	176

		"Telemedicine" [Mesh] OR "mobile health*" OR "m-Health*" OR eHealth* OR Wearable* OR "Health Tech*" OR app[tw] OR apps*[tw] OR application* OR "application program*" OR "Mobile Applications"[Mesh] OR "Mobile Medical Apps" [tw] OR "fit bit*" OR "oura ring*" OR "smart watch*" OR smartwatch* OR "wearable computer*" OR "wearable device*" OR "smart band*" OR "iphone*" OR "smartphone*" OR "android*" OR "fitness track*" OR "activity track*" OR "facebook app*" OR "MyfitnessPal" OR "google fit")) AND (acceptance or attitudes or perception or feasibility) AND ("maternal care*" OR antepartum* OR prenatal* OR perinatal*		
Web of Science	05.08.2023	((((TS=((MH"Expectant Mothers" OR "pregnan*"))) AND TS=((MH"Collaboration" OR "Collaborat*" OR MH"Self-Management" OR "motivation" OR "motivation interview*" OR "commitment*" OR "patient commitment*" OR "women commitment*" OR "motivation" OR "motivational interview*" OR "patient-provider relation*" OR "patient- provider interact*" OR "therapeutic alliance" OR "clinical interact*" OR "communicat*" OR empath* OR "mutual understand*" OR trust* OR expectation* OR "therapeutic relation*"))) AND TS=((feasibility OR acceptability OR exploratory OR mixed-method* OR "mix method*" OR "quantitative method" OR "mixed method*" OR MH "qualitative stud*" OR "qualitative method*" OR "qualitative" OR narratives OR "thematic analysis" OR interviews OR MH "Phenomenology" OR MH "Phenomenological Research"))) AND TS=((handheld* OR mobile* OR pda OR "handheld PC*" OR "personal data assistant*" OR MH "Computers, Hand-Held+" OR "Handheld Computers" OR ipad* OR "tablet computer*" OR "tablet PC*" OR iphone* OR smartphone* OR "cell phone*" OR "cellular phone*" OR "Cell Phones" OR "mobile phone*" OR "mobile device*" OR wireless* OR mHealth* OR "Telemedicine" OR "mobile health*" OR "m-Health*" OR eHealth* OR Wearable* OR "Health Tech*" OR app OR apps* OR application* OR "application program*" OR "Mobile Application*" OR "Mobile Medical App*" OR "fit bit*" OR "oura ring*" OR "smart watch*" OR smartwatch OR "wearable computer" OR "wearable device" OR "smart band" OR "iphone" OR "smartphone*" OR "android*" OR "fitness track*" OR "activity track*" OR "facebook app*" OR "MyfitnessPal" OR "google fit*")))	Eglish language	462
Scopus	06.08.2023	(TITLE-ABS-KEY (("expectant mother*" OR "pregnan*")) AND TITLE-ABS-KEY (("self care" OR "self-management" OR "shared decision mak*" OR "shared decision-mak*" OR " therapeutic alliance")) AND TITLE-ABS-KEY ((handheld* OR mobile*)) OR TITLE-ABS-KEY (("handheld pc*" OR "personal data assistant*" OR "computers, handheld" OR ipad* OR "tablet computer*" OR "tablet pc*")) OR TITLE-ABS-KEY ((iphone* OR smartphone* OR "cell phone*" OR "cellular phone*" OR "mobile phone*" OR "mobile	English articles	46

		device*" OR wireless* OR mhealth* OR "telemedicine" [mesh] OR "mobile health*" OR "m-health*")) OR TITLE-ABS-KEY ((ehealth* OR wearable* OR "health tech*" OR app[tw] OR apps*[tw] OR application* OR "application program*" OR "mobile applications" OR "mobile medical apps" [tw] OR "fit bit*" OR "oura ring*" OR "smart watch*" OR smartwatch* OR "wearable computer*" OR "wearable device*" OR "smart band*" OR "iphone*" OR "smartphone*" OR "android*" OR "fitness track*" OR "activity track*" OR "facebook app*" OR "myfitnesspal" OR "google fit")) AND TITLE-ABS-KEY (("maternal care*" OR antepartum* OR prenatal* OR perinatal*)))		
Embase	06.08.2023	('pregnant woman'/exp OR 'expectant mother'/exp OR 'pregnancy'/exp) AND ('wearable device'/exp OR 'wearable apparatus' OR 'wearable device' OR 'wearable equipment' OR 'wearables') AND ('acceptance'/exp OR 'technology acceptance model'/exp OR 'attitude'/exp OR 'attitude' OR 'behavior, permissive' OR 'behaviour, permissive' OR 'faculty attitude' OR 'knowledge, attitudes, practice' OR 'permissive behavior' OR 'permissive behaviour' OR 'permissiveness' OR 'rejection (psychology)' OR 'rejection, psychology') AND ('randomized controlled trial'/exp OR 'controlled trial, randomized' OR 'randomised controlled study' OR 'randomised controlled trial' OR 'randomized controlled study' OR 'randomized controlled trial' OR 'trial, randomized controlled')	English Articles	10
Coachrane Library	06.08.2023	Expectant Mothers in Title Abstract Keyword OR pregnant mothers in Title Abstract Keyword AND wearable technology in Title Abstract Keyword AND acceptance in Title Abstract Keyword	English Articles	73
Science Direct	07.08.2023	"technology" OR"sensor" OR "wearable device" OR "activity tracker"AND "experience"AND "antenatal care" AND "pregnant" OR "pregnancy"OR "maternal" Title, abstract, keywords: "pregnant women" OR "Expectant Mother" OR"gestational diabetes"AND wearable device OR activity tracker AND "technology adoption" OR technology acceptanceTitle: wearable device OR acceptability OR feasibility OR wearable sensor or activity sensor	English Articles	215

Appendix 2 : Table 1. Shows characteristics of the selected studies

Name of study	Authors, date of publication	Country of study	Study aim	Methods	Type of wearable device in intervention	Sample size	Key findings
A web-based mHealth intervention with telephone support to increase physical activity among pregnant patients with overweight or obesity: Feasibility randomized controlled trial.	Tainayah T, Xu F, Sridhar S, et al.2022	Canada	Evaluate acceptability and feasibility of a pilot mHealth lifestyle intervention for pregnant patients with overweight or obesity	mixed methods acceptability and feasibility RCT	Activity tracker, text messaging, mobile website, calls, digital scale	n=33	High adherence to activity tracker, 73% found it helpful, useful components: digital scale, coach calls, activity tracker, text messages
A Pilot Randomised Controlled Trial of a Text Messaging Intervention with	Cheung NW, Blumenthal C, Smith BJ, et al.2019	Australia	Assess feasibility of individualized text messaging and wearable activity monitor for	The study pilot RCT, Quantitative Study	Fitbit Flex activity monitors + text messaging program.	60 women n=40 in the intervention n=20 in the control group	The study demonstrated the feasibility of implementing an intervention program that involved text

Customisation Using Linked Data from Wireless Wearable Activity Monitors to Improve Risk Factors Following Gestational Diabetes			postpartum glucose tolerance testing and health behavior improvement				messaging linked with wearable activity monitors. Many participants found the program appealing.
A Technology-Based Pregnancy Health and Wellness Intervention (Two Happy Hearts): Case Study	Jimah T, Borg H, Kehoe P, et al.2021	Canada	Assed use of technology (THH intervention prototype) in monitoring and supporting well-being of a pregnant woman	Case study design, quantitative analysis, qualitative analysis and user experience Assessment	Oura ring and THH mobile app	n=1	Positive experience, potential for technology in monitoring and supporting pregnant women
Feasibility, acceptability, and preliminary efficacy of a single-arm, remotely	Whitaker KM, Jones MA, Dziewior J, et al.2022	USA	Examine feasibility, acceptability, and effectiveness of remote	Single arm pilot study	Fit bit activity tracker + remote coaching sessions	n=34	High recruitment, retention, session attendance, and Fitbit

delivered health coaching intervention to increase physical activity and reduce sedentary behavior during pregnancy			health coaching with wearable activity tracker				adherence; 100% satisfaction
A feasibility study of activity tracking devices in pregnancy	Kominiarek, Michelle A. Balmert, Lauren C. et al.2019	USA	Assess attitudes and feasibility of integrating activity tracking devices into prenatal care	Analytical cross-sectional Design	Fitbit Flex, counseling session on safe exercise	Phase 1 n= 25 phase 2 n= 48	High motivation and satisfaction, challenges in daily adherence
Feasibility and user acceptability of Breezing, a mobile indirect calorimetry device, in pregnant women with overweight or obesity	K.Leonard, A.Pauley,P.Guo et al. 2023	USA	Assess feasibility and acceptability of Breezing device for measuring REE in pregnant women with overweight or obesity	Prospective study +RCT	Breezing mobile calometry device + mobile application	n= 27	Promising wearable tool, 68% compliance, technical difficulties affected enjoyment

Feasibility of smart wristbands for continuous monitoring during pregnancy and one month after birth	Grym K, et al. 2019	Finland	Assess practicality of wearable wristbands for continuous monitoring from second trimester to one month postpartum	Mixed method, observational feasibility design	Garmin VivoSmart HR wristband, website /mobile app	n=20 pregnant women	Average usage of 182 days, decline postpartum; issues with accuracy, technical challenges
Long-Term IoT-Based Maternal Monitoring: System Design and Evaluation	Sarhaddi F, Azimi I, Labbaf S, et al.2021	Finland	Develop and evaluate IoT-based maternal monitoring system	longitudinal study	Smartwatch, smartphone, mobile app, blood pressure device (OMRON M3)	n=28 high-risk pregnancies	Feasible and practical, importance of data collection duration, sampling frequency, energy efficiency.
Using a consumer-based wearable activity tracker for physical activity goal setting and measuring steps in pregnant women with gestational	Ehrlich, S.F., Maples, J.M., Barroso, C.S. et al.2021	USA	Examine performance and acceptability of Fitbit Charge 3 for physical activity tracking in pregnant women with GDM	Mixed Methods	FitBit Charge 3	n=15	Valid for step counting, willingness to engage in physical activity, barriers related to time, family, discomfort

diabetes mellitus: exploring acceptance and validity							
Women's Attitudes Toward Self-Monitoring of Their Pregnancy Using Noninvasive Electronic Devices: Cross-Sectional Multicenter Study	Schramm K, Grassl N, Nees J, et al.2019	Germany	Examine opinions on adopting eHealth gadgets for pregnancy monitoring	cross-sectional multicenter survey.	None (survey only)	N=509 Pregnant women	Open to eHealth devices, prefer as complement to traditional care, frequent monitoring desired

Appendix 3: Interview questions:

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1. Reflecting on the past two months, how would you overall describe your experience with stress management and well-being?
2. What does taking care of your own stress management and well-being mean to you during pregnancy?
3. Are there things that help you manage your stress and take care of your well-being? Could you provide examples? What thoughts and feelings do these things evoke in you?
4. Are there things that make it difficult for you to manage stress and take care of your well-being? Could you provide examples? What thoughts and feelings do these things evoke in you?
5. How have you been managing your stress and well-being over the past two months? Could you provide examples?
6. Have any encounters/meetings/relationships influenced your stress management and well-being maintenance over the past two months? Could you describe the situation in more detail? Where did it happen? Who was present?
7. Has the smart ring played any role in your stress management and well-being over the past two months? Could you provide examples?
8. Can you recall instances where healthcare professionals, including your nurse, have supported you in stress management and maintaining well-being?
9. ...and from elsewhere, for example, hospitals, support groups?

Specific questions related to the smart ring if they haven't been discussed during the interview:

- How did you find using the OURA smart ring, mobile application, and cloud service?
- What information did you review from the OURA mobile app 1) independently and 2) with the nurse?

- What technical issues did you encounter, if any? How did you resolve any technical problems?
- How do you perceive the suitability of the smart ring for 1) independent stress management and well-being during pregnancy and 2) guidance in the maternity clinic?
- Are there any missing necessary functions?
- What potential changes have you made in your behavior during the use of the smart ring?
- What factors have prompted these changes in your behavior?
- Would you continue using the ring in the future?
- Is there anything else you would like to share about your experience with the ring?

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