PERINATAL mHEALTH APPS: AN EVALUATION OF CONTENT AND THE PERCEPTIONS OF WOMEN WHO USE THEM

BY

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Abstract

The number of mobile health applications for perinatal women has grown more than any other type of health application. The reason for this growth is likely due to the number of women who have mobile devices, the comfort level perinatal women have for accessing information on the internet, and the desire women have for health information while having children. Despite the growth in availability, there is limited information in the literature about the clinical use of perinatal mobile health applications as educational tools.

The purpose of this study was to evaluate and assess the perinatal mobile health application marketplace and to understand the perceptions of women who used them for health information during childbearing. This information is important for healthcare providers, app developers, and the development of mobile health application standards and guidelines. The number of perinatal mobile health applications were assessed along with the information provided by the apps. Then, a select group of applications that supplied significant perinatal content were further evaluated for content accuracy, usability and security by women's health experts. Key findings were that there were several available applications but many did not supply recommended educational content. Most applications evaluated by women's health experts were found to be satisfactory.

To understand women's perceptions of perinatal mobile health applications, study participants were interviewed using a guide derived from concepts in the Health Information Technology Acceptance Model. Themes that emerged from this study were that women are able to gain support for their

pregnancy through the use of mobile applications, they like that information is personalized to them based on their gestational age, and they expected providers to be able to recommend applications to them.

Based on findings from this study, recommendations for healthcare providers are to find out what health applications are commonly used by patients in their practice and evaluate them using a systematic scoring system such as the Healthcare Smartphone Applications Evaluation Tool. Based on evaluations, providers should consider recommending a selection of health applications to future patients. Application developers should work with healthcare providers or professional healthcare organizations to ensure content accuracy. In addition, they should develop apps based on established guidelines and seek strategies to personalize information distributed to users. Mobile health application guidelines are currently being developed by healthcare organizations working in collaboration. These guidelines should include a process for verifying health application quality and provide a resource for providers to review and share evaluations of health applications.

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Chapter 1: Background

Problem and Significance

The purpose of routine prenatal and postpartum care is to optimize health for women and children by assessing for risks and providing timely education about healthy behaviors (Akkerman et al., 2012). Pregnancy is considered a teachable moment where health education is likely to cause individuals to make positive health changes by reducing lifestyle risk or increasing healthy behaviors (McBride, Emmons, & Lipkus, 2003). Teachable moments occur when a cuing event, such as pregnancy, initiates an emotional response that increases an individual's perception that their healthy behaviors could improve outcomes or decrease risk (McBride et al., 2003).

Perinatal education is a core component of routine prenatal and postpartum care. Benefits of antenatal education include helping women recognize pregnancy risk factors that should be evaluated by a provider (You, Wolf, Bailey, & Grobman, 2012), decreasing childbirth anxiety (Ferguson, Davis, & Brown, 2013), or improving their knowledge of healthy behaviors for themselves or their babies (Ota, Hori, Mori, Tobe-Gai, & Farrar, 2015). An example of education impacting outcomes was found with pregnant women in an intervention group who were given a preeclampsia educational tool while the control group received standard education (You et al., 2012). The women in the intervention group had increased clinically relevant knowledge about preeclampsia, a pregnancy related hypertensive disorder with warning signs that should be evaluated by a provider, over the control group (You et al., 2012).

Other researchers found that a prenatal education program that promoted healthy behaviors for pregnant adolescents decreased the likelihood of the adolescents having a low birth weight baby (Covington, Peoples-Sheps, Buescher, Bennett, & Paul, 1998). This is significant because low birth weight infants are more likely to have complications as a newborn than infants of average birth weight (March of Dimes, 2014).

Perinatal education can positively impact breastfeeding. The American Academy of Pediatrics [AAP] (2012) policy statement recommends that infants are exclusively breastfed for the first six months of life. Breastfeeding provides benefits to both mothers and children. Benefits for women who breastfeed include a decreased risk of developing type 2 diabetes and certain types of cancer; their infants experience decreased risk of infections and sudden infant death syndrome (Office on Women's Health [OWH], 2014). The U.S. Healthy People 2020 goal is for 60.6% of infants to meet the AAP breastfeeding recommendations (Office of Disease Prevention and Health Promotion [ODPHP], 2014). As of 2011, only 49.4% were breastfeeding at six months (ODPHP, 2014). Breastfeeding goals can be supported through educational interventions. A randomized control trial where the intervention included breastfeeding classes before delivery and breastfeeding support four weeks after delivery resulted in adolescent mothers' breastfeeding their infants longer than mothers who did not receive the intervention (Wambach et al., 2011). Hedberg (2013) recommended prenatal and postpartum breastfeeding education classes to alleviate the perceived barrier of lack of support for women who participate in the special supplemental nutrition program

for Women, Infants, and Children (WIC).

Perinatal education is generally provided to women during preconception counseling appointments, individual prenatal care appointments, or group prenatal care appointments (AAP, & American College of Obstetricians and Gynecologists [ACOG], 2012). For women who may become pregnant, educational topics may include family planning, risk for sexually transmitted infections, and risks related to the patient's health or family history (AAP, & ACOG, 2012). Routine prenatal care allows the provider to identify risk factors, develop a plan of care, and provide holistic education to women relevant to their stage of pregnancy (AAP, & ACOG, 2012). Prenatal testing, nutrition, physical activity, childbirth, newborn care, and breastfeeding are examples of prenatal health promotion topics (Akkerman et al., 2012).

Childbirth education classes are another means of educating patients. Classes are typically offered through the community or healthcare entities as optional sources of information. Educational topics may include labor and birth information, pain control options, newborn care, or breastfeeding (Mayo Clinic Staff, 2014). Childbirth education programs can increase women’s pregnancy knowledge and answer their pregnancy related questions (Godin et al., 2015)

While perinatal education is important because lifestyle behaviors during pregnancy can affect both the mother and the child, challenges exist for adequate delivery of health information to patients. First, not all women in the U.S. seek regular prenatal care. As of 2007, only 70.5% of women obtained prenatal care in the first trimester and received adequate prenatal care throughout their pregnancy

(ODPHP, 2014). A second challenge for providers is delivering adequate information to patients when they are limited by time and resources (Lucas, Charlton, & Yeatman, 2014). Finally, childbirth education classes may not be appealing to pregnant women. According to the Listening to Mothers III survey, a national survey of 2400 women who gave birth in a U.S. hospital in 2012, 47% never attended childbirth preparation classes (Declercq, Jakala, Corry, Applebaum, & Herrlich, 2013). Researchers found many women do not attend childbirth education classes because they have too many other obligations competing for their time (Morton & Hsu, 2007).

In addition to challenges related to patients receiving education through prenatal care or childbirth education classes there is so much information to give patients related to their pregnancy, it may be overwhelming. The amount of new information that a person can learn at a given time is limited (Van Merriënboer & Sweller, 2010). If new information is too complex or there is too much extraneous information given, learning may be limited due to cognitive overload (Van Merriënboer & Sweller, 2010). In order to enhance learning, complex information may need to be further broken down or be available to review more than once (Sweller, Van Merriënboer, Paas, 1998). This may not be feasible during routine perinatal care appointments or in childbirth education classes due to time constraints.

Mobile health applications (mHealth apps) may serve as a useful tool to supplement and reinforce information given to patients by providers. Applications (apps) are software programs developed for mobile devices that accomplish a

specific task or function (Aungst, Clauson, Misra, Lewis, & Husan, 2014). They are distributed on platforms such as Google Play™ or iTunes App Store® for the purpose of being downloaded to mobile devices by users. App content is designed to be viewed on a small screen where content should be succinct with limited amounts of extraneous information (Nielsen & Budiu, 2013). Apps created for educational purposes facilitate rapid access to information, quick reviews of content, and convenience for learners (Educause, 2010).

MHealth apps are a genre of apps developed for purposes such as providing health information or motivating patients toward healthy behaviors (Garcia-Gómez et al., 2014). MHealth apps can support health education by providing easily accessible information, enhancing learning by providing images or animations alongside explanations (DiPaola, & Orrin, 2013), and reiterating information given by providers (Conn, 2015). According to IMS Health (2015), the number of available mHealth apps increased over 100% since 2013. There were, at the time of their assessment, over 165,000 mHealth apps. Approximately 7% or 11,550 of the mHealth apps were related to women's health (IMS Health, 2015).

MHealth apps for pregnant or postpartum women have the potential to provide information that could reinforce teaching supplied by healthcare providers. In 2015, 85% of 18-29-year-olds and 79% of 30-49-year-olds owned smartphones (Pew Research Center, 2015). In addition, 77% of 18-29-year-olds and 68% of 30-49-year-olds have used their smartphones to look up a health condition in the past year (Pew Research Center, 2015). In addition to having the

technology to use apps and the willingness to use a mobile device to look up health information, pregnant women search and seek recommendations for mHealth apps about pregnancy (Asiodu, Waters, Dailey, Lee, & Lyndon, 2015; Wilcox et al., 2015). Healthcare providers may be able to assist patients and enhance learning by recommending quality mHealth apps.

Purpose of Study

MHealth apps are increasingly available due to the explosive growth in the app marketplace and the prevalence of mobile devices. However, the literature about using them for patient education is scant because the mHealth app field is so new. Mobile apps offer unique benefits and challenges based on how they are designed and used. The purpose of this study was to evaluate the user experience of mHealth apps by patients for perinatal education. User experience is a broad understanding of how a user interacts with a system (U.S. Department of Health and Human Services, 2017) and is dependent on the system's usefulness or functionality, usability, and desirability (Schmidt & Etches, 2014). It is important for all elements to be addressed to attract and retain users (Schmidt & Etches, 2014). It is important to assess mHealth apps for these elements to understand if patients are likely to want to download and use them to obtain perinatal information.

This study first determined if mHealth apps were useful for perinatal education by evaluating the extent they address educational topics recommended during perinatal care. Once mHealth app content was assessed, the most useful apps were further evaluated for usability, content accuracy and security using the

Healthcare Smartphone App Evaluation tool [HSAET] (Jin & Kim, 2015). After evaluating available perinatal mHealth apps, pregnant or postpartum women were interviewed for their perceptions and experiences using apps as a perinatal education tool.

Because of the paucity of documentation about mHealth apps usage as a patient education tool, this research study was conducted in two phases. The first phase did not involve human subjects; it evaluated the current pregnancy education mHealth app landscape. The second phase of the study did involve human subjects by exploring the experiences of women who accessed and used mHealth apps for information during their childbearing experience using a qualitative approach.

Phase I. The first objective during this phase of the study was to evaluate the usefulness of mHealth apps designed for perinatal education. This was done by examining the extent mHealth apps address educational content recommended for low-risk pregnant or postpartum women by comparing recommended routine perinatal education topics (see Appendix B) with topics available on apps. The Institute for Clinical Systems Improvement (ICSI) recommend routine prenatal care educational topics for each prenatal and postpartum visit with a healthcare provider (Akkerman et al., 2012, p. 1-2). To evaluate mHealth apps, these topics were grouped into content to be delivered in the first trimester, the second trimester, the third trimester, and the postpartum period through the first six weeks after delivery (see Appendix B). Next, Google Play™ and the iTunes App Store® were searched for apps offering perinatal health information. Identified

mHealth apps were evaluated to determine which of the recommended educational topics they addressed. The evaluation was done to understand if mHealth apps designed to provide health information could reinforce teaching by the healthcare provider.

After assessing the breadth of maternity content available in app format, the apps that offer the most information were further evaluated using an app evaluation tool. The apps were evaluated using the HSAET tool by currently practicing women's health professionals recruited to participate in this evaluation. While this assessment did not offer an exhaustive review, it does supply a systematic evaluation of a selection of mHealth apps by healthcare professionals. Information obtained from this assessment may serve as a model for future app reviews, support the HSAET as a viable app evaluation tool, provide recommendations for app developers, and reveal areas for future research.

Phase II. The next phase of the study was to evaluate the perceptions of usability and desirability by women who used mHealth apps for health information during their pregnancy or postpartum periods. A potential challenge for using mHealth apps as a patient educational tool is design limitations. Apps are designed to be used on small, portable devices where users touch the screen rather than use a more precise mouse or touchpad to click on information (Nielsen & Budiu, 2013). Because of the limited screen space, mobile app designers must limit extraneous information and present content in a concise format and build clickable links or buttons large enough for fingers to use without a mouse (Nielsen & Budiu, 2013). It is not clear if mHealth app design is useful to patients

because of the succinct nature of the information or if content is too minimal to be helpful.

In the second phase of this study, participants were asked to describe their experiences using mHealth apps along with what they liked and did not like about them. People will not use what they do not like, even if the system is useful (Schmidt & Etches, 2014). A better understanding of the information available on mHealth apps for pregnancy information, how effectively individuals are able to access information using an app format, and how women feel about apps as an educational tool will serve as a foundation for future health promotion strategies using mobile technology that are acceptable to patients. Findings from this study help explain the strengths and limitations of using mHealth apps as a patient education tool and could be used to create recommendations for improving mHealth app design and for developing mHealth app policy guidelines.

Research Questions

The following research questions will be explored:

1. To what extent do mHealth apps meet the recommended educational needs of childbearing women?
2. To what extent are mHealth apps considered desirable and usable for pregnant or postpartum women seeking information about childbearing?

Theoretical Considerations

MHealth apps developed for the purpose of educating childbearing women are an example of a current health enabling technology readily available to

patients. Technology used in healthcare has social and cultural constructs that influence how it is accepted (Sandelowski, 2000a). In healthcare, technology has been used for numerous purposes including amplifying senses for assessment, saving time and improving workplace efficiency, and administering treatments (Sandelowski, 2000a). New technology is transient as it becomes expected or obsolete over time. Historically nursing professionals are often called upon to implement technology, assist patients with understanding and accepting the technology, and become experts in the practical use of the technology (Sandelowski, 2000a).

The purpose of this study was to understand the usefulness, usability, and desirability of mHealth apps as an educational tool during pregnancy and the postpartum period. There are benefits, limitations, and scant definitive information in the literature about using apps for health information. Therefore, to summarize the experiences of women who used apps during pregnancy or postpartum, a qualitative descriptive design will be used as a method of inquiry. Qualitative descriptive studies rely on studying phenomena in its natural state and not on theoretical constructs (Lambert & Lambert, 2012).

While a theoretical framework was not be used as a basis for this study, theoretical considerations were used to ensure comprehensive inquiry. To evaluate the use of mHealth apps to educate pregnant women the cognitive load theory (CLT) and the health information technology acceptance model (HITAM) model were selected as theoretical frameworks to develop the interview guide.

According to the CLT, short term memory is limited to approximately

seven elements before becoming overwhelmed and elements are forgotten (Sweller, Van Merriënboer, & Paas, 1998). Long term memory, on the other hand, is essentially limitless. In order to transfer new knowledge into long term memory, learners must organize information into schemas that are incorporated into their own mental architecture for storing and retrieving information. The ability to transfer information into long term memory depends on the difficulty of the information (intrinsic load), the amount of extraneous information (extrinsic load), and the relevance of the information (germane load) (Sweller, Van Merriënboer, & Paas, 1998). The transfer of information into long term memory can be enhanced by decreasing intrinsic and extrinsic load while increasing the germane load.

An understanding of the CLT is useful for the design of this study because there is a significant amount of prenatal and postpartum information to be shared with patients. Perinatal education topics are recommended based on the stage of the patient's pregnancy (Akkerman, 2012). Providing information based on the gestational age of the pregnancy decreases intrinsic load because the information is broken down into more manageable pieces. The germane load during pregnancy is high due to pregnancy being a teachable moment where women are receptive to learning about healthy behaviors and are willing to make behavior changes based on information received (McBride et al., 2003). In the clinical setting, extraneous cognitive load may be increased by limited time with the provider, multiple areas of concern, and the distractions of a busy clinic.

MHealth apps are an example of a health information technology (HIT)

resource that could be used to help women learn about pregnancy and postpartum topics. MHealth apps may decrease intrinsic load by providing concise chunks of information that can be reviewed multiple times. However, mHealth apps could hinder learning by increasing extrinsic load through poor design or unfamiliarity with the system.

To understand the perceptions of women who used mHealth apps to obtain perinatal information, the Health Information Technology Acceptance Model (HITAM) was used as a framework for creating interview questions.

The HITAM model was based on the technology acceptance model (TAM). According to the TAM, the perceived ease of use influences beliefs about a computer system's usefulness (Davis, 1989). Together the perceived ease of use and perceived usefulness of a system influence a user's attitude about the system. A user's attitude leads to their intent to use or not use the system (Davis, 1989). Perceived ease of use is related to the usability of the system and how the user experiences its interface. The ease of use and usefulness impact user's attitudes or the desirability to use the system.

Kim and Park (2012) expanded on the TAM to better understand factors that lead to a person using HIT, such as mHealth apps. The HITAM adds the concepts of perceived threats and normative beliefs or social influences impacting the perceived usefulness of a HIT system (Kim & Park, 2012). A perceived threat is related to a person's health status and their beliefs and concerns about their health condition (Kim & Park, 2012). Normative beliefs or social influences regarding a HIT are the social or community influences that can motivate a

patient to use a system (Kim & Park, 2012). In addition, a patient's HIT self-efficacy and beliefs about the reliability of a HIT system impact both perceived usefulness and perceived ease of use (Kim & Park, 2012). How the patient views their health threats, the usefulness of a HIT system, and how easy the system is to use leads to their HIT system attitudes, intended behaviors, and ultimately, their behaviors (Kim & Park, 2012). Healthcare providers influence all aspects related to a patient's HIT acceptance according to the HITAM model. They provide information about their health status and address health concerns, they influence beliefs about the subjective norms of HIT, they are able to address HIT reliability, and by assisting patients with understanding a HIT system, they increase a patient's HIT self-efficacy.

Childbearing women are learners who are especially open to health information and adopting healthy behaviors (McBride et al., 2003). Pregnant women are a demographic likely to engage in accessing mobile devices for information, they likely have concerns about their pregnancy and a desire to know more information. MHealth apps may meet their educational needs and support a healthy pregnancy. However, according to the HITAM model, there are several factors that influence a person's acceptance of health technology. Some of these factors are related to the technology itself and some are related to the user's contextual experience. The HITAM provides a resource to evaluate multiple aspects of a women's perceptions of using mHealth apps as a health information resource within the context of an adult learner receiving prenatal care from a healthcare professional.

Significance of Study

Education for childbearing women is comprehensive, but spread throughout pregnancy and the postpartum period depending on the time during pregnancy/gestation. Healthy, low-risk women are generally scheduled for prenatal care visits every four weeks until the 28th week of pregnancy, then every two weeks until the 36th week, and finally weekly until delivery (AAP & ACOG, 2012, p. 106). Women may have questions related to pregnancy between their scheduled appointments or need reinforcement of the education their provider reviewed. MHealth apps may be a useful resource for patients to access and review as needed from their mobile device. This study will help evaluate the availability of quality mHealth apps for health information.

Evaluating mHealth apps for use with childbearing women is important in order to offer guidelines for policy development, health professionals, and app developers. Currently there is limited regulation in mHealth apps as patient education tools. The U.S. Food and Drug Administration (FDA) evaluates apps that transform a mobile device into a healthcare device or an accessory for a healthcare device (2015). An example of an app that can be used for a healthcare device is one that could help providers diagnose and treat a patient's chest pain (Mauer, 2016). MHealth apps that provide general information about health conditions are considered low risk to patients and do not require oversight (FDA, 2015). However, healthcare organizations are interested in mHealth app guidelines. Recently, Xcertia, a collaboration supported by the American Heart Association (AHA), the American Medical Association (AMA), the Healthcare

Information and Management Systems Society (HIMSS), and the DHX group, a nonprofit organization supporting digital health innovation, was formed to support patients and providers by developing guidelines for mHealth app privacy and security, content quality, interoperability, and evidence of clinical efficacy (HIMSS, 2016 & Xcertia, n.d.). Because there is limited regulatory oversight ensuring informational mHealth app quality, this study will provide insight regarding the mHealth app landscape and will serve as a model for app analysis used within a specific population. This information may help drive the development of mHealth app guidelines and policies.

In this study, mHealth apps were evaluated for the accuracy and relevance of the topics addressed. App developers may not have accurate healthcare knowledge. In a recent study of an app content assessment tool, researchers found over half of pregnancy due date calculator apps could not accurately determine a pregnancy due date and/or the gestational age of a fetus based on the first day of the last menstrual period (Chyjek, Farag, & Chen, 2015). MHealth apps will be selected for this study from internet searches and searching app distribution platforms. In this study, all perinatal apps were evaluated by the researcher to determine the extent their content addresses recommended health education topics that pregnant or postpartum women should receive during routine prenatal care as outlined by the ICSI. The five apps that address the most perinatal topics were further evaluated for content accuracy, security, and usability using the HSAET tool. The purpose of this phase of the study was not to systematically evaluate all available perinatal apps. Apps can be easily updated, modified, or deleted by

developers. Therefore, an evaluation of all apps would likely be outdated quickly. The purpose of this evaluation was to provide information on the mHealth apps most likely to be clinically useful due to the educational topics addressed to determine if apps should be considered as a patient education tool.

While healthcare practitioners may use different procedures to determine what information should be used to educate patients, nurses are often responsible for distributing resources and supporting patients' educational needs. Nurses provide anticipatory guidance about pregnancy and childbirth. They ensure patients understand explanations that have been given to them by providers, and they make sure all their questions are answered. When a new technology is implemented into a patient care setting, it is often nurses who have direct contact with the technology, act as a liaison with the patient, and develop practical knowledge of how to use it best (Sandelowski, 2000a). If mHealth apps are to be used in a patient care setting as an instructional supplement, this study will provide insight for nurses regarding app implementation and use.

Although the mHealth app marketplace is continuing to evolve and grow, understanding how women access and use informational mHealth apps could help healthcare providers educate their patients and successfully implement mHealth apps as an educational tool within their practices. Findings from this study could assist app developers design apps that more effectively meet the educational needs of pregnant and postpartum women. In addition, this study provides a model for evaluating mHealth apps that could be used to develop mHealth app policy recommendations and guidelines.

Definitions of Terms

The "Desirability" of an mHealth app means that people want to use it because it has appealing qualities (Merriam Webster, 2017).

A "Smartphone" is a mobile device that offers features beyond calling and texting. Most have the ability to record and play videos, take or display photos, and surf the web (TechTerms, 2010). "Modern smartphones, such as the iPhone and Android based phones can run third-party applications, which provide limitless functionality" (TechTerms, 2010).

The "Security" of mHealth apps refers to the digital measures protecting devices from unauthorized use (Techopedia, 2017).

The "Usability" of mHealth apps is the extent a user can effectively navigate the app content to search for and locate desired information. Usability depends on the quality attributes of how easy the app is to learn, how efficient the app is to use, how easy it is to remember how the app works, how easy it is to make or correct errors within the app, and the satisfaction of users with the app (Nielsen, 2012).

MHealth app "Usefulness" refers to the degree an app satisfies the needs of the user (Schmidt & Etches, 2014).

Assumptions

1. Women want to learn about pregnancy when they are pregnant/expecting.
2. Women assume content provided in an mHealth app is accurate.
3. Healthcare providers want to provide patients with accurate pregnancy

information in a format that is usable for their patients.

4. Apps are accessible to women of childbearing age.

Review of Literature

The databases PubMed, CINAHL, Medline, and Health Source Nursing Academic Edition were searched using the terms mobile health or mHealth or m-health, and app* and maternity or lactation or obstetric or pregnancy or maternity.

Forty-one articles were located. Duplicate articles were removed from consideration. Articles were excluded if the mHealth apps were only used by providers, if they did not provide education to patients, or if they were not in English. The review was limited to articles published since 2011 because of the improvement and growth in mobile technology since that time.

After applying exclusion criteria, five articles were retained for evaluation. The results of the literature review are limited because of the lack of publications on this topic. The articles selected for review were published in 2015 and 2016. The recent publications correspond to the increase in the number of available mHealth apps in the past few years.

There was only one study that used an mHealth app solely to deliver health information to patients. Knight-Agarwal et al. (2015) developed an app to educate pregnant women about health during pregnancy. In this six-week pilot study, all ten participants had smartphones, researchers taught them how to use the app, participants were asked to complete an electronic survey midway through the study period and participate in an interview at the end of the study Findings were that women found the app useful, but wanted additional features (Knight-

Agarwal et al., 2015).

Asiodu, Waters, Dailey, Lee, and Lyndon (2015) did not use a specific mHealth app to deliver information, instead they gathered qualitative data through semi-structured interviews and participant observation to determine how African American women used social media, including mHealth apps, to obtain breastfeeding information during and after their first pregnancy. All pregnant women in their study had access to smartphones (n=14) and most used apps or social media at least weekly (91%). Participants sought additional sources of information if they questioned content accuracy, and spent more time accessing pregnancy apps than postpartum apps (Asiodu et al., 2015). Wilcox et al. (2015) also conducted a qualitative study with pregnant women (n=15) and health providers (n=12) to assess experiences using various mHealth options, including apps, for educating pregnant women. They found that all pregnant participants had mobile phones and positive experiences with available options, but they may not use all pregnancy related mHealth apps they downloaded. Both patients and providers expressed concern about who is responsible for quality (Wilcox et al., 2015).

Choi, Lee, Vittinghoff, and Fukuoka (2016) conducted a randomized controlled pilot study with low-risk pregnant women to determine if there was a difference in physical activity in women who used an mHealth app to reinforce teaching and provide motivational information than those who did not use the app. All participants (n=29) received a Fitbit accelerometer to record their physical activity along with prenatal education on the benefits of physical activity.

Intervention group participants (n=14) also received information about goal setting and reducing barriers to physical activity and an mHealth app that provided motivational messages and tips for healthy behaviors to reinforce teaching. There was no difference in physical activity between the groups, but the intervention group did report fewer barriers to physical activity than the control group (Choi et al., 2016).

Ledford, Canzona, Cafferty, and Hodge (2016) conducted a randomized controlled pilot study to determine the differences between patients who used an mHealth app journal to record their pregnancy experiences and questions for their provider versus patients who used a spiral notebook for the same purpose. Of the 175 participants, 173 had a device capable of downloading apps. There were no differences in birth outcomes between the control and the intervention groups. However, the intervention group was more likely to have the mHealth app available to review with the provider at their appointments than the control group was to have their spiral notebook. Additionally, the intervention group rated their care higher than the women in the control group (Ledford et al., 2016).

Discussion. Research on the use of mHealth apps for childbearing women is currently limited. There were no studies that evaluated app quality or the potential to provide information to patients throughout their pregnancies. However, findings provide useful baseline information for this and other studies.

Overwhelmingly participants had phones capable of downloading and running mHealth apps. This corresponds to the Pew Research Center findings (2015) that most women of childbearing age have smartphones capable of

accessing mHealth apps even if they do not have internet access in the home. Only two research teams described introductory sessions where participants were taught to use the apps (Choi et al., 2016; Knight-Agarwal et al., 2015). The qualitative studies evaluated how women accessed and used apps, without influencing their choice of use (Asiodu et al., 2015; Wilcox et al., 2015). Women downloaded mHealth apps related to their pregnancies independent of their providers (Asiodu et al., 2015; Wilcox et al., 2015). Based on these reported methods, it appears an introductory or app training session may not be necessary for participants to effectively use mHealth apps.

Pregnant women are finding mHealth apps on their own. They are interested in seeking them out, downloading them to their devices, and using them (Asiodu et al., 2015; Wilcox et al., 2015). They are accessing them frequently (Asiodu et al., 2015). They want apps that have varied functions (Knight-Agarwal et al., 2015). They do not use an app if it does not meet their expectations (Asiodu et al., 2015). It is unclear what aspects of mHealth design are most important to patients. Challenges related to using the technology were not reported in the reviewed studies. It could be that patients had no difficulty accessing or using the apps. Or patients had difficulty and resolved the issues themselves, or they had difficulty and decided not to use the apps.

The findings from this literature review support the need to explore how mHealth apps could meet the educational needs of childbearing women throughout their pregnancy and postpartum periods. Evaluating mHealth apps will add information about app functionality as an educational tool, usability

challenges, and features that are desirable by users to help inform healthcare providers interested in guiding patients in the use of mHealth apps.

Research Design

The purpose of this study was to understand what information is available in an app format to educate pregnant and postpartum women and to understand the experiences of women who used apps to obtain information during their childbearing experience. This study was conducted in two phases. The first phase was an evaluation of mHealth apps geared toward providing information about pregnancy and the immediate postpartum period. This evaluation involved an assessment of mHealth app usefulness for the childbearing patient by evaluating and summarizing the extent pregnancy related mHealth apps address recommended perinatal educational content. The apps that appeared to best meet educational recommendations were further assessed by women's healthcare professionals for content accuracy, usability, and security using an app evaluation tool.

The second phase of this study utilized a qualitative descriptive design methodology to understand the experiences of women who accessed and used an mHealth app to obtain health information during their pregnancy. The purpose of a qualitative descriptive study is to capture and summarize an experience (Sandelowski, 2000b; Lambert & Lambert, 2012). "Qualitative descriptive study is the method of choice when straight descriptions of phenomena are desired" (Sandelowski, 2000b, p.334). Theoretical principles will be used to develop interview questions, but not as a framework to evaluate variables. This is an

appropriate design for this study because of the limited information available on using mHealth apps for patient education and the potential for the mHealth app field to grow in the future.

Phase I. The first phase of this study evaluated the extent mHealth apps provide relevant information for pregnant or postpartum women. This phase did not use human subjects and was used to inform the second phase of the study. To evaluate mHealth app usefulness, apps were located by searching the app distribution platforms Google Play™, the iTunes App Store®, the blog iMedical Apps (http://www.imedicalapps.com/), and the Google search engine using the search terms pregnancy and education. App distribution platform searches were limited to Google Play™ and the iTunes App Store® because they are the most popular app distribution sites containing most available apps (Dogtiev, 2016). Apps were included for evaluation if they were available for free, were in English, and offered educational information to pregnant or postpartum women. Information about the app name, app developer, number of downloads, average rating, and the source used to obtain the information was recorded (see Appendix A) for analysis after information about app content was obtained.

After creating a list of educational perinatal apps, they were evaluated for the extent they covered educational topics for childbearing women as recommended by the Institute for Clinical Systems Improvement. The ICSI has outlined recommended educational topics that should be discussed with women at each prenatal visit based on their gestational age (Akkerman et al., 2012, p. 1-2). These topics were grouped by the researcher into first trimester topics relevant to

the first thirteen weeks of pregnancy, second trimester topics for weeks 14 through 26, third trimester topics for weeks 27 to birth, and postpartum topics (see Appendix B). First trimester educational topics included physiology of pregnancy, first trimester fetal growth, physical activity, nutrition, nausea and vomiting, warning signs, prenatal testing (maternal labs), and prenatal testing (fetal screening) (Akkerman et al., 2012). Second trimester topics included physiology of pregnancy, second-trimester fetal growth, quickening, preterm labor education, prenatal classes, and gestational diabetes mellitus (Akkerman et al., 2012). The third trimester topics were physiology of pregnancy, third-trimester fetal growth, awareness of fetal movement (fetal kick counts), management of late pregnancy symptoms, warning signs for pregnancy induced hypertension, labor and birth issues, and when to call the provider (Akkerman et al., 2012). In the postpartum period, recommended topics were contraception, postpartum depression, and breastfeeding (Akkerman et al., 2012). The researcher evaluated app usefulness by downloading apps onto a mobile device and comparing the informational topics presented on the app with the recommended educational topics for childbearing women.

Results of the app content evaluation were used to determine which apps offered the most comprehensive coverage of recommended content and to summarize how frequently mHealth apps cover recommended perinatal educational topics. The five apps that addressed the most recommended perinatal topics were further evaluated using the HSAET tool to systematically assess mHealth apps based on their content, interface design, and app security (Jin &

Kim, 2015). These are important factors for providers to consider before recommending specific mHealth apps to their patients.

Content validity of the preliminary 35-item HSAET survey was evaluated by five healthcare professionals and resulted in the elimination of two survey items (Jin & Kim, 2015). Construct validity and reliability of the 33-item survey was tested with 200 nursing and medical students. Based on a factor analysis the survey was further refined to include 23 items based on a three-factor model. The first factor, contents, included items related to accuracy, understandability, and objectivity. The second factor, interface design, consisted of items related to consistency, suitability of design, and accuracy of wording. The third factor, technology, included items related to security. The factors demonstrated internal consistency reliability with high Cronbach alphas of .84, .89, and .87, respectively. The reliability for the total survey was high with Cronbach alpha of .91.

The researcher recruited nine practicing women's healthcare professionals to evaluate perinatal mHealth apps. The HSAET was explained to the evaluators by the researcher. Each of the evaluators were asked to select two of the five selected mHealth apps to evaluate using the HSAET. The evaluators were not assigned specific apps to review. For each HSAET item, the evaluator was instructed to score the item with a 0 to 3. A zero indicated the app did not meet the criteria at all, a 1 meant the criteria was met "a little," a 2 meant the criteria was met "a fair amount," and a 3 meant the criteria was met "a lot" (Jin & Kim, 2015). The item scores were added together to obtain a total app evaluation score.

A score of 23 or less is considered poor, a score between 24 to 46 is average, and a score between 47 to 69 is satisfactory (Jin & Kim, 2015).

For this study, nine practicing perinatal health practitioners were asked to evaluate two of the five apps selected for further review using the HSAET tool. Each app was given a score between 0 to 69 based on the tool items to determine if the app is poor, average, or satisfactory. The purpose of evaluating maternity apps with HSAET tool is to better understand their content quality, design, and security. Findings from this evaluation will help providers have a better understanding of the functionality of apps as a patient education tool, serve as a model for how providers are able to evaluate other mHealth apps, and may inform the development of mHealth app policies.

Phase II. After available mHealth apps created for maternity education were evaluated, the second phase of the study began. In this phase, women who used apps were interviewed for their perspectives about mHealth app usability and desirability. The researcher conducted individual interviews with women who used mHealth apps during their pregnancy to obtain health information. These semi-structured interviews involved questions about their pregnancy experiences, technology experience, experiences using apps in general (see Appendix C), and experiences using mHealth apps for pregnancy information (see Appendix D). They were also asked about their perceptions of mHealth app usability, usefulness, desirability, and their intentions related to using mHealth apps for health information in the future (see Appendix D). Finally, they were asked to talk aloud as they completed the task of opening one of the perinatal mHealth apps

preloaded onto the researcher's smartphone and asked to find information about the signs of preterm labor and how to position a baby for breastfeeding. Talking aloud as they complete a realistic task allows researchers to better understand how and why women access information from an mHealth apps (Nielsen, 2012b).

Women were asked about their pregnancy information and their technology experiences because their backgrounds may have influenced their acceptance of apps as an information resource. Women's perceptions of app usability and desirability may be influenced by health concerns related to their pregnancy and beliefs related to their technology self-efficacy (Kim & Park, 2012).

It is important for products, such as mobile apps, to be usable, desirable, and useful (Barnum, 2002). Usability principles are especially important for mobile apps because they generally do not have tutorials on how to use them and they tend to be intermittently used (Nielsen & Budiu, 2013). Usability principles refer to the degree a product is easy to learn, remember how to use, is efficient, able to be used with few errors, and is overall satisfactory to users (Nielsen, 2012). A heuristic evaluation is one method of evaluating usability and is done by comparing user experiences to recognized usability principles. The talk-aloud method of evaluating usability provides a demonstration of actions and provides insight for why decisions were made (Nielsen, 2012b).

Usability testing is generally conducted with four to six representative users to uncover most challenges without significant redundancy (Nielsen & Pernice, 2010). For this study, the researcher is not interested in the interface

design of a single app. Rather, the goal of this evaluation is to better understand challenges patients may have accessing and using mHealth apps in general to understand if apps can be relevant as a patient education tool. For this study, user perceptions of mHealth apps usability will be obtained by asking women who used apps during their pregnancy questions about their experiences based on usability principles and by asking them to talk through a representative task (see Appendix D). Asking the participants to use a mHealth app to locate information allows the researcher to verify or further question participant explanations about their experiences.

In addition to questions about mHealth app usability, participants will be asked about their perceptions on usefulness and desirability. It is unclear in the literature if apps with more content are perceived as more useful and desirable or not. A better understanding of women's perceptions could help providers recommend relevant mHealth apps and assist developers in improving app design.

Sample and Setting.

Participants were recruited for individual interviews in Boise, Idaho and the surrounding communities. Inclusion criteria for this study were women who were pregnant or who had delivered within the previous six months. Participants were required to be over the age of 18 and able to speak and read English. In addition, they must have self-reported that they accessed an mHealth app to obtain pregnancy or postpartum information. Individual interviews took between 30 to 60 minutes to complete. Select participants were asked by email to review and provide insight on the themes that emerged from the analysis.

Participant recruitment and interview sessions continued until no new information related to the research questions was discovered. A total of 16 participants were interviewed for this study. Patton (2015) suggests the number of participants for a qualitative study should be flexible based on data saturation because interviews may uncover a significant amount of rich data requiring a smaller number of participants or they may produce a small amount of data requiring more participant interviews.

Recruitment Overview

Since the participants for this study were recruited solely from the Boise, Idaho area, institutional review board (IRB) oversight was obtained from Boise State University's IRB. The University of Kansas Medical Center (KUMC) provided an IRB Authorization Agreement designating Boise State as the organization providing IRB review. Recruitment for participation in the study was initiated after IRB approval. A letter describing the study along with recruitment flyers was sent to the Central District Health offices that provide reproductive health services and the Women's, Infants and Children (WIC) program in Boise, Idaho and surrounding communities. Recruitment flyers were also distributed at Boise State University. Recruitment advertisements were placed on Boise State University's School of Nursing internal announcement television, the School of Nursing Facebook page, Boise Craigslist, and in Boise Nextdoor neighborhoods. In addition, women who participated in the study were given a letter (see Appendix E) and study flyer to distribute to friends they thought may meet study criteria.

Flyers describing the study directed interested participants to contact the researcher, by phone or email (see Appendix G). Recruitment advertisements contained the same information as the study flyer. The researcher verified inclusion criteria and scheduled a time for the interview. Before interviews began, the consent form was reviewed with participants and then signed after all questions were answered. Participants received a copy of the consent form.

Data Collection

Semi-structured individual interviews with pregnant or postpartum women were held at agreed upon times and locations convenient for the participant and the researcher. Interviews were audio recorded using two digital audio recorders. The purpose of two audio recorders was to have a back-up device in the event of technology failure. Participants were referred to by a pseudonym during the interview to protect their anonymity. Interviews were transcribed verbatim by the researcher and checked for accuracy. After transcription, data was saved on a secure server at Boise State University and the interviews were deleted from the recording devices. Interviews consisted of semi-structured, primarily open-ended questions using an interview guide (Appendix D) to ensure consistency and to gather information about the experiences and perceptions of mHealth apps. However, non-scripted follow-up questions were asked for the purposes of clarifying and better understanding participant experiences.

Data Analysis

After transcription, interview data were organized into meaning units which are sentences or paragraphs that relate to a central concept (Graneheim &

Lundman, 2004). The meaning units were condensed by shortening the information while preserving the content essence. The condensed meaning units were coded or labeled and then organized into themes for analysis by the researcher. An inductive analysis approach was utilized by evaluating the experiences of women to identify patterns in their experience (Patton, 2015). Themes that emerge from the study assisted in understanding women's perceptions of mHealth apps as a health education tool in pregnancy. Data analysis began after the first interview and continued after each subsequent interview. This technique allowed the researcher to continually review data and recognize when data saturation has been reached.

Trustworthiness

Lincoln and Guba (1985) outline strategies for enhancing the trustworthiness of qualitative research through credibility, dependability, and transferability. Techniques used to demonstrate credibility or trust in the findings include recruiting participants that allow for rich variation in the data, illustrating how data were abstracted, and member-checking (Graneheim & Lundman, 2004). While this study was limited to a single geographic area, participant recruitment was conducted through a variety of community agencies and through a snowball technique. The purpose of recruiting from multiple sources was to draw participants from different backgrounds who may add variation in the study data. A description of how data were categorized into themes along with direct quotes from participants will be used to demonstrate the credibility of the data analysis process (Graneheim & Lundman, 2004). Finally, the researcher practiced

member-checking by clarifying data or verifying findings by contacting participants by email and asking them to review and provide input on the themes that emerged during the analysis process.

Dependability can be verified through an inquiry audit technique to authenticate findings (Lincoln & Guba, 1985). For this study, the researcher maintained a reflexive journal to document experiences and to analyze possible analysis influences in the interpretation of results (Cresswell, 2013). At the completion of the study, the researcher sought an inquiry audit from Dr. Jane Grassley, an independent qualitative researcher at Boise State University School of Nursing. Dr. Grassley was included in the IRB application as a member of the study team, but will not participate in the study until after data analysis has begun. Her role was to review the field notes, reflexive journal, and data analysis procedures to verify findings.

Transferability of findings is dependent on the conclusions of others who review the research (Lincoln & Guba, 1985). Transferability is supported through thick descriptions (Lincoln & Guba, 1985) and clearly defined procedures (Graneheim & Lundman, 2004). This study was conducted in two phases. The first phase was conducted to understand the mHealth app market for maternity information. Understanding the types of available apps will assist the researcher in understanding the experiences of women who used apps for information during their pregnancy, thereby allowing for a thick description. To further aid in the transferability of findings, the researcher will clearly outline the procedures used in the study.

Human Subjects Considerations

Participants were not enrolled in the study until approval for the study was granted by Boise State University's institutional review board and an authorization agreement for Boise State oversight was obtained from the University of Kansas Medical Center. Individuals interested in the study were given a copy of the informed consent form (see Appendix F) explaining the purpose of the study and the study procedures. Inclusion and exclusion criteria were reviewed and if criteria were met and the participant agreed to the study protocol, interviews were conducted. The researcher filed the consent forms in a locked cabinet at Boise State University. A list of individuals who participated in the study along with their contact information was maintained by the researcher on a secure server at Boise State University for the purposes of following up with study questions after the interview. During the interviews, interviewees were referred to by a pseudonym to maintain anonymity. After transcription was complete, audio files were deleted. Transcribed data files are stored on a secure server at Boise State University. During analysis, data from interviews were aggregated, further minimizing the chance individual responses are identifiable.

Participants were given a small token of appreciation after the initial interview was completed (a $10 gift card), funded by the researcher. They were notified that the researcher may contact them via email or telephone to verify or clarify information and that they would not be given a second gift card for verifying information.

Time Frame

Analysis of mHealth app usefulness began during the winter of 2017. The Institutional Review Board approval was granted from Boise State University in May 2017. An authorization agreement from the University of Kansas Medical Center designating Boise State University to have oversight of this study was granted in July 2017. Data collection began in July 2017 and ended in August 2017. Data analysis began after the transcription of the first interview and was conducted throughout the process.

Scope of Manuscripts

The results of this study will be disseminated through three manuscripts that will describe the extent individual mHealth apps have the ability to provide relevant pregnancy or postpartum information and are usable and liked by patients.

Availability of perinatal mHealth apps. The first manuscript summarizes available perinatal mHealth apps and describes the extent mHealth apps meet the recommended educational needs of childbearing women. The content of individual mHealth apps will be compared to educational topics recommended for low risk patients during prenatal care and postpartum care. The manuscript describes which topics are frequently addressed in apps and which are not.

This manuscript informs readers about the current state of pregnancy related mHealth apps available on the two largest app distribution platforms. It provides insight on the content available in an app format. The significance of this

manuscript is to provide background information for future mHealth app research and to assist providers with deciding how to include mHealth apps as a patient education tool.

Drs. Wambach, Conley, and Manos co-authored this manuscript.

Evaluation of mHealth apps. The second manuscript was intended to be a companion to the first. The primary focus of the manuscript was to describe the HSAET tool and how it was used by women's health professionals to evaluate five current mHealth apps that provide education to pregnant or postpartum women. The tool's purpose is to evaluate app content accuracy, user interface, and app security. Using the tool, an evaluator assigns an overall score based on assessment components.

This evaluation tool and description of results could serves as a model for healthcare providers interested in evaluating mHealth apps. This information could inform further research on the use of mHealth apps.

Drs. Wambach, Conley, and Manos co-authored this manuscript.

Perceptions of mHealth apps. The third manuscript provided a qualitative description of the experiences and perceptions of women who obtained health information from an app during their pregnancy or postpartum period. Results included perceptions of information received during pregnancy or after delivery, a description of how women sought health information, and their experiences or perceptions of using mHealth apps for information. The purpose of this manuscript is to help healthcare providers better understand how apps might be used in their practice to supplement current patient education practices.

Drs. Wambach and Baird co-authored this manuscript.

Summary

MHealth apps geared toward providing health information have become increasingly available. They allow individuals the opportunity to access information on a topic in one location from a mobile device. Users do not need to wait for an appointment with their healthcare provider to seek answers nor do they need to wait until they have access to a desktop or laptop computer to search for information.

Women of childbearing age are likely to own a smartphone or mobile device capable of downloading mHealth apps (Pew Research Center, 2015). When women are pregnant or have delivered a baby, they are likely to have questions. MHealth apps designed to provide perinatal information may be a resource for women turn to for answers.

While mHealth apps are designed to provide targeted information, little is known about the content provided in an app format for pregnant or postpartum women. Developers are limited by a small mobile device screen. A small screen size means information must be concise and navigation buttons may be difficult to locate or use (Nielsen & Budiu, 2013). Currently there is no oversight, peer review process, or guidelines for mHealth apps that provide education.

This study evaluated how well mHealth apps address educational topics recommended for pregnant and postpartum women. This information provides insight as to how apps could supplement perinatal education. Select apps were further evaluated for content accuracy, usability, and security by women's health

professionals. This process may provide a model for clinicians interested in evaluating apps for their practice and could be used to generate guidelines regarding mHealth app quality. Finally, women who used apps for pregnancy or postpartum information were interviewed about their experiences. This information could be used to recommend strategies to evaluate and improve mHealth apps for clinical use.

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Chapter 2

Connor, K., Wambach, K., Conley, Q., & Manos, L. (2018). Availability of perinatal mHealth applications. Manuscript in preparation.

The manuscript presents an assessment of available perinatal mHealth apps. The manuscript was co-authored by Karen Wambach, PhD, RN, Quincy Conley, PhD, and LaVerne Manos, DNP, RN.

Abstract

Background: Pregnant and postpartum women receive a significant amount of health information during perinatal appointments with their healthcare providers. Providers often supplement teaching with printed handouts. Providers could also supplement teaching with mHealth applications (apps) that reinforce perinatal health information. Women of childbearing age are likely to own a smartphone, are comfortable using electronic resources, and will have their mobile device on-hand when questions arise. Unfortunately, little is known about the availability of perinatal mHealth apps or the content they address. ***Aims:*** The purpose of this review was to gage the content available within perinatal mHealth apps against the recommended educational topics for pregnant and postpartum women to create a foundation for clinical use and future research. ***Method:*** The Google Play™ and iTunes® distribution platforms were searched for apps that provide perinatal health information. App content was evaluated against the 24 health education topics recommended for low-risk pregnant and postpartum women by the Institute for Clinical Systems Improvement. ***Results:*** There were 505 apps located using the search term pregnancy. After applying exclusion criteria, 81 apps were retained for further review. Five apps addressed 21-24 recommended educational topics while 20 addressed 11-15 topics. Most apps addressed topics related to nutrition, nausea, and fetal growth. Few apps covered contraception, warning signs of pregnancy induced hypertension, or postpartum depression. ***Conclusion:*** While mHealth apps may support perinatal education, further

research should be conducted to evaluate content for accuracy, clinical use, and patient perceptions.

Keywords: mHealth applications, patient education, perinatal

Availability of Perinatal mHealth Apps

Women are regularly scheduled for routine visits with a healthcare provider during pregnancy and after delivery. During prenatal visits, providers assess physical parameters of pregnancy, health risks, provide information about pregnancy and fetal development, and support women in understanding and practicing healthy lifestyle behaviors. Because a significant amount of information is given during prenatal visits, information is often supplemented with paper handouts, pamphlets, or booklets providing information about healthy behaviors during pregnancy. Education is important during pregnancy because it is a time when women are likely to make positive health changes because they believe their actions significantly impact the health of their fetus (McBride, Emmons, & Lipkus, 2003).

Supporting healthy behaviors is important during pregnancy because of the effect on women and children. While current methods of educating and supplementing information are useful, health information technology (HIT) tools might be beneficial for consumers. Mobile Health applications (mHealth apps) are an example of a HIT tool that could be used to educate patients. Apps are software programs downloaded onto a mobile device that perform specific functions (Aungst, Clausson, Misra, Lewis, & Husan, 2014). Apps that specifically support health are mHealth apps. MHealth apps are thought of as convenient and accessible by consumers. Potentially, they can be used to educate, track information, communicate with providers, or connect individuals with similar health concerns.

Perinatal apps are a specific genre of mHealth apps that serve to provide health information throughout the pregnancy and postpartum experience. Perinatal mHealth apps may be a particularly useful tool for women of childbearing age to obtain health information because this population is likely to have a mobile device capable of downloading apps. According to the PEW research center, 85% of people ages 18-29 have a mobile device.[3] Women of lower socioeconomic groups are more likely to have a mobile device rather than a computer to access the Internet. However, their service may be cut-off or cancelled due to financial issues (Pew Research Center, 2015). In addition, 77% of 18-29-year-olds have used their mobile device to look up health information within the past year (Pew Research Center, 2015). Because women of childbearing age are likely to have a device to access mHealth apps and they are comfortable using electronic resources to seek answers to health-related questions, providers should understand the information available to patients in an app format.

An understanding of mHealth apps and the information they provide is important in order to better understand how they might be used to support patients. MHealth apps have the potential to supplement patient education received in the clinical setting, motivate patients to maintain healthy behaviors, and improve communication between patients and providers. Before apps can be effectively explored by researchers, an understanding of the types of available mHealth apps for a specific health population should be conducted. The purpose of this paper is to evaluate the perinatal mHealth app landscape in order to inform

perinatal providers about the information available to women who use apps during and after their pregnancy. It will also serve as a foundation for further research about perinatal mHealth apps.

Background

Pregnant and postpartum women should receive health information relevant to their stage of the childbearing process. The Institute for Clinical Systems Improvement (ICSI) created guidelines for routine prenatal care that include the health education topics that should be addressed by providers throughout the perinatal period (Akkerman et al., 2012). In the first trimester, the ICSI recommends providers discuss the physiology of pregnancy, fetal growth, physical activity, nausea and vomiting, warning signs, prenatal maternal laboratory tests, and fetal screening tests (Akkerman et al., 2012). In the second trimester, providers should discuss the physiologic changes of pregnancy, fetal growth, quickening, preterm labor, prenatal classes, gestational diabetes, and fetal kick counting (Akkerman et al., 2012). In the third trimesters, providers should discuss the physiologic changes of pregnancy; fetal growth; the management of late pregnancy symptoms; the warning signs of pregnancy induced hypertension, labor and delivery issues; and when to call the provider (Akkerman et al., 2012). After delivery, the provider should provide education on contraception, postpartum depression, and breastfeeding (Akkerman et al., 2012).

While providers educate women about relevant perinatal health topics during office visits, they are likely to have questions or want more information between their appointments. Finding health information on the Internet and

finding health information on an mHealth app have similarities and differences that should be recognized. When using the Internet to find health information, search terms are entered into a web browser and multiple sources of information are rapidly obtained. While a person is able to search several informational websites for an answer to their question, they may become overwhelmed by the amount of information available. Finding information on an app is different because apps are content specific and created by a single source. A person interested in a health topic would search on an app distribution platform such as Google Play™ or iTunes®. To access the app, they would need to download and then open it on their device. Because there is a limited amount of information that can be viewed on a mobile device, they would likely need to scroll or search the app for the information they are looking for. This process takes longer than using a web browser for information initially but is more efficient after the app has been downloaded. In addition, because the app is now on their device, it becomes a readily available resource that belongs to them. To remove the app, they must specifically choose to uninstall the app to remove it from their device. Because apps, in a sense, belong to an individual after downloading to their device, it makes sense for providers to encourage patients to download mHealth apps that support their educational needs. To begin the process of assessing perinatal mHealth apps for clinical use, an inventory of available perinatal mHealth apps should be undertaken.

Literature Review

Mhealth apps are increasingly available for patients to manage illnesses, access health care, and receive health information (Silva, Rodrigues, de la Torre Diez, Lopez-Coronado, & Saleem, 2015). Patients who use mHealth apps to manage chronic illness like that apps are specific to their needs and have features to track their health (Birkhoff & Smeltzer, 2017). Research into the field of mHealth apps is growing rapidly (Silva et al., 2015). However, at this time, research evaluating perinatal mHealth apps that provide health information is scant but promising. Researchers using apps with populations of pregnant or postpartum women found that most had smartphones capable of downloading apps (Asiodu, Waters, Dailey, Lee, & Lyndon, 2015; Knight-Agarwal, et al., 2015; Ledford, Canzona, Cafferty, & Hodgem, 2016; Wilcox et al, 2015) and many women used mHealth apps during their pregnancy (Asiodu et al., 2015; Wilcox et al., 2015). Pregnant women used apps for social networking (Asiodu et al., 2015) they were comfortable accessing apps for the first time during their pregnancy (Knight-Agarwal, et al., 2015; Choi, Lee, Vittinghoff, & Fukuoka, 2016) and they sought interactive features within apps (Knight-Agarwal, et al., 2015). These findings support the use of mHealth apps in the clinical setting with childbearing women because women have access to the technology and are comfortable using it during pregnancy.

Researchers compared patients who used an app as a journal to record questions for their providers with patients who used a spiral notebook as a journal during their pregnancies (Ledford et al., 2016). While there were no differences in

pregnancy outcomes, patients who used an app for a journal were more likely to have it with them during their prenatal visits with their provider. In addition, they rated their communication with their provider higher than the patients who used a spiral notebook to record questions (Ledford et al., 2016). This is an intriguing finding because patient satisfaction is important and because patients who ask their specific health questions will get their questions answered. Other researchers found no difference in physical activity between patients who were given a fitness accelerometer tracker and those who were given the tracker along with an app that sent regular motivational messages, however, the patients with the app reported fewer barriers to physical activity (Ledford et al., 2016). Because there was a difference in perceived barriers toward physical activity between the groups, further research is warranted.

Interestingly, both patients (Asiodu et al, 2015) and providers (Wilcox et al., 2015) have concerns about the quality of some mHealth apps. When patients have a concern about the information obtained in an app, they may choose to uninstall the app or they look to other sources to verify or refute the information (Asiodu et al, 2015). Providers are concerned about the accuracy of content provided in mHealth apps and who is responsible for app quality (Wilcox et al., 2015). Currently mHealth apps are not considered a medical device and are not required to be evaluated by the U.S. Food and Drug Administration (2015). Current research does not support an improvement in birth outcomes among patients that use mHealth apps during pregnancy and those that do not (Ledford et al., 2016; Choi et al., 2016).

Methods

To conduct this evaluation of current perinatal mHealth apps Google Play™ and iTunes® were searched using the term "pregnancy". The titles of the apps and the names of the developers were recorded. After creating a list of available apps, the researcher conducted an initial screening of the apps by viewing the descriptions and the posted pictures of app pages. Apps were retained for this review if they provided education for pregnant or postpartum women. Apps were excluded from this review if they provided information on a single topic such as contraction timing or calculating a due date, if they cost money, or if the content did not pertain to pregnancy education, such as apps created for recreational gaming.

After the initial screening, apps were downloaded to the researcher's mobile device. At this stage, apps were excluded from review if a registration code was required for access such as in cases where the app was created by an insurance company or a specific healthcare organization, if payment was required to access educational content, if they were not in English, if content did not provide perinatal education, or use of the app required access to a social media account or a phone number. Apps that required an email account to access were retained. Apps that provided pregnancy information, were free, and used the English language were evaluated. The included apps were then opened and the content topics were compared to the 24 educational topics recommended for pregnant and postpartum women by the ICSI. Frequencies were calculated on the number of topics included.

Results

A search for perinatal mHealth apps on Google Play™ and iTunes® yielded a total of 505 apps (Google Play™ *n* = 223; iTunes® *n* = 282) (see Figure 1). An initial review for free apps in English that provided perinatal education yielded 235 apps that met criteria (Google Play™ *n* = 56; iTunes® *n* = 179). Of the 56 apps downloaded from Google Play™, 28 were excluded from further review because they were off-topic (*n* = 11), not in English (*n* = 6), were not accessible on the researcher's device (*n* = 4), required a paid upgrade to access content (*n* = 4), required a registration code to access (*n* = 2), or required access to a social media account to open (*n* = 1). A total of 28 apps located on Google Play™ were retained for content review. Of the 179 apps downloaded from iTunes®, 122 were excluded because they were off-topic (*n* = 47), not in English (*n* = 5), were not accessible on the researcher's device (*n* = 20), not free (*n* = 48), required a registration code (*n* = 3), required a social media account (*n* = 2) or a phone number (*n* = 1) to open. A total of 53 mHealth apps were retained for content review.

A total of 81 mHealth apps from Google Play™ and iTunes® were evaluated for the presence of recommended perinatal health topics (Table 1). Of the apps retained for this review, 23 (28%) addressed between 2 and 5 of the recommended education topics for pregnant or postpartum women, 15 (19%) addressed 6 to 10 topics, 20 (25%) addressed 11 to 15 topics, 18 (22%) addressed 16 to 20 topics, and 5 (6%) addressed 21 to 24 topics. The most commonly addressed topics (see Table 2) were nutrition (*n* = 64; 79%), nausea and vomiting

(*n* = 59; 73%) and first trimester fetal growth (*n* = 57; 70%). The topics least likely to be addressed were postpartum contraception (*n* = 3; 4%), warning signs of pregnancy induced hypertension (*n* = 15; 19%), and postpartum depression (*n* = 18; 22%).

Figure 1. Selection of Perinatal mHealth apps for evaluation

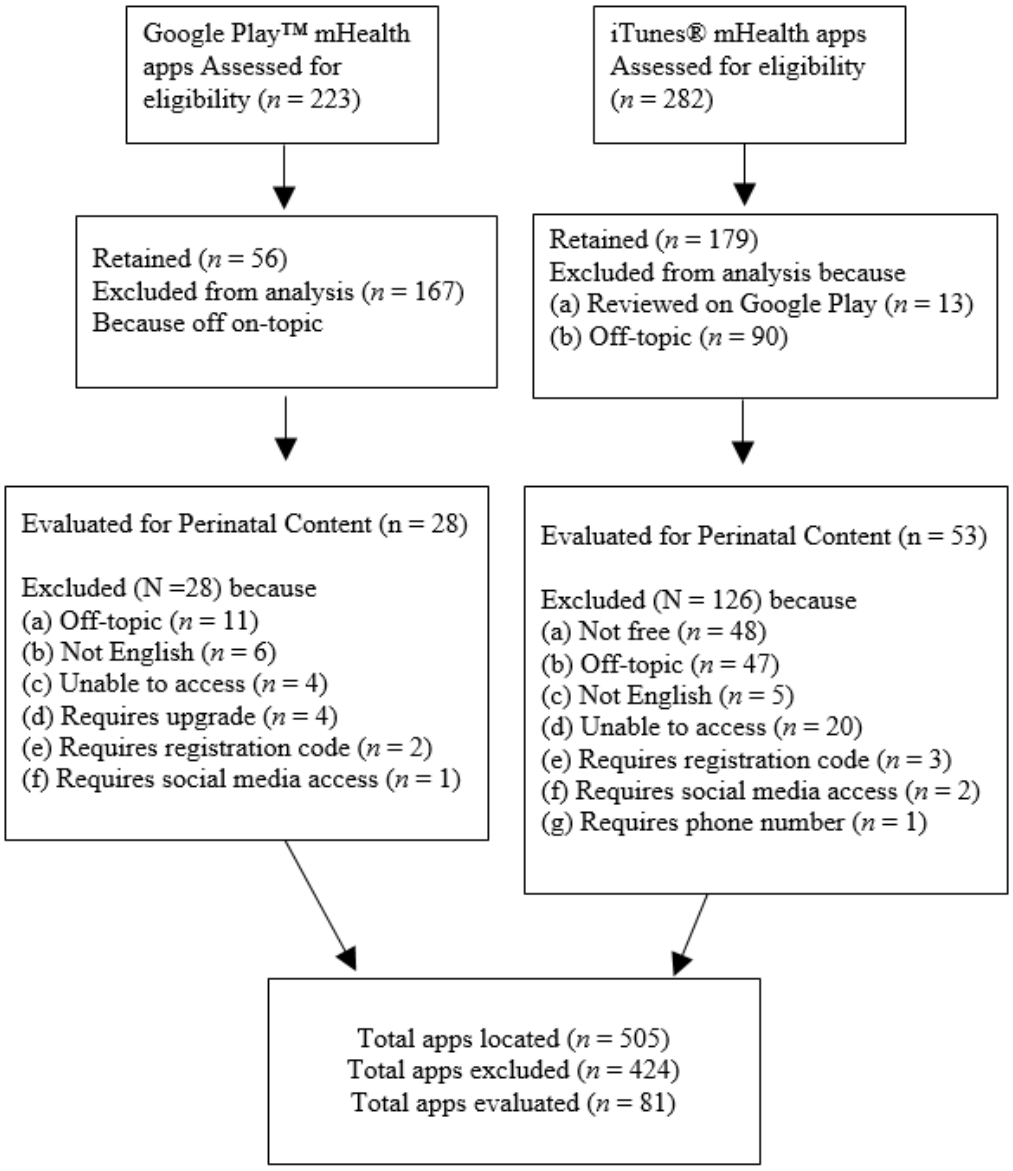

Table 1

Number of Perinatal Topics Addressed by Perinatal mHealth Apps (N = 81)

Number of Topics	*N* (%)
Between 2 – 5 Topics	23 (28)
Between 6 – 10 Topics	15 (19)
Between 11 - 15 Topics	20 (25)
Between 16 – 20 Topics	18 (22)
Between 21 – 24 Topics	5 (6)

Table 2

Perinatal Topics Addressed by 81Perinatal mHealth Apps Based in the 24 Institute for Clinical Systems Improvement (ICSI) Recommendations

Topic	*N* (%)
First-trimester	
Physiology of Pregnancy	55 (68)
Fetal Growth	57 (70)
Physical Activity	56 (69)
Nutrition	64 (79)
Nausea and Vomiting	59 (73)
Warning Signs	19 (23)
Prenatal Testing of Maternal Labs	39 (48)
Fetal Screening	41 (51)

(continued)

Table 2 (continued)

Topic	*N* (%)
Second-trimester	
Physiology of Pregnancy	49 (60)
Fetal Growth	56 (69)
Quickening	36 (44)
Preterm Labor Education	20 (25)
Prenatal Classes	29 (36)
Information on Gestational Diabetes Mellitus	35 (43)
Fetal Kick Counting	23 (28)
Third-trimester	
Physiology of Pregnancy	47 (58)
Fetal Growth	54 (66)
Management of Late Pregnancy Symptoms	39 (48)
Warning Signs of Pregnancy Induced Hypertension	15 (19)
Labor and Delivery Issues	36 (44)
When to Call the Provider	33 (41)
Postpartum	
Contraception	3 (4)
Postpartum Depression	18 (22)
Breastfeeding Concerns and Support	29 (36)

Discussion

This evaluation of the perinatal mHealth app landscape provides background for future research and clinical applications. This evaluation focused on mHealth apps that provided patient information throughout pregnancy and the postpartum period. There were many apps that addressed a single topic relevant to childbearing women, however, they were not included in this review. Little is known about mHealth apps for patient education. This study evaluated mHealth apps that covered a spectrum of topics relevant to the specific population of childbearing women. Once mHealth apps for this population are inventoried, further research should be done to evaluate content quality and effectiveness as a patient education tool. This method of surveying and evaluating mHealth apps could be done in future studies to evaluate single topic apps and mHealth apps for different patient populations.

As expected, there were many pregnancy related apps (n = 505). However, only 81 (16%) apps offered perinatal health information because many "pregnancy" apps were off-topic. Of those that supplied health information, most lacked recommended content. In addition, many mHealth apps were difficult to navigate and locate specific health information. Further research should be conducted regarding patients' perceptions of mHealth app usefulness. The lack of relevant perinatal mHealth apps and apps that are difficult to use is concerning because women of childbearing age are likely to own a mobile device and may use it to seek perinatal information through an mHealth app. It may be difficult for patients to find quality perinatal health apps. Because the research has not

been conducted on available perinatal mHealth apps, providers are not likely to recommend them to women. This leaves women seeking their own apps to use as a resource. They may become frustrated with apps in general and with their providers for not recommending quality mHealth apps to them. Finally, some important perinatal health topics are conspicuously absent from most apps. Providers may want to specifically address these topics with patients who regularly use apps for perinatal information.

Limitations

Assessing perinatal mHealth apps based on content has limitations. Searching for apps on an app distribution platform likely did not yield all possible perinatal health apps because of the search term used. Therefore, this assessment may be incomplete. In addition, apps can be modified by developers at any time, creating a changing perinatal app environment. Apps may be listed on different platforms with different names or with different developer accounts. Each app distribution platform requires developers to create a unique account based on their operating system. It is possible that the same app was reviewed separately for each platform. This would cause the app to be represented twice rather than once in this evaluation. Another limitation is mHealth app formatting. This evaluation process screened apps for specific perinatal education topics; the researcher had to figure out how to navigate each app to find specific information. It is possible that content could have been missed because the researcher was not able to locate information within an app. Finally, this evaluation was based on mHealth apps that covered the breadth of recommended perinatal health topics; apps that were

developed for a single topic were excluded from this review. For example, apps that were created solely to address breastfeeding were not evaluated, although they could be useful education tools.

Conclusion

Perinatal mHealth apps are increasingly available because of the growth in the app marketplace, the high percentage of women of childbearing age who have mobile devices, and the number of people who use their mobile device to find health information. However, most apps located using the search term pregnancy do not provide perinatal information. Most mHealth apps that provide perinatal information do not address all recommended prenatal and postpartum health education topics. Future studies should be done to determine the perinatal topics most desired by childbearing women. In addition, the accuracy of mHealth app information and the experiences of women who seek information from apps are unknown. Further research regarding mHealth app content accuracy and user experiences should be conducted in order to create mHealth app development guidelines, evaluation models, clinical recommendations, and strategies to ensure mHealth app quality. MHealth app development guidelines and an evaluation model could be used to evaluate single topic perinatal mHealth apps, future perinatal mHealth apps, and mHealth apps designed as tools to educate other patient populations.

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Chapter 3

Connor, K., Wambach, K., Conley, Q., & Manos, L. (2018). Evaluating perinatal mHealth applications for use as a patient education tool. Manuscript in preparation.

The manuscript presents an evaluation of representative perinatal mHealth apps. The manuscript was co-authored by Karen Wambach, PhD, RN, Quincy Conley, PhD, and LaVerne Manos, DNP, RN.

Abstract

Mobile Health applications serve a variety of purposes to improve health. However, applications that inform but not diagnose or treat medical conditions are not regulated. Pregnant and postpartum women are likely to have a mobile device, a history of using electronic resources, and questions related to pregnancy. MHealth applications can be used to supplement patient education provided during routine perinatal care appointments. However, scant research is available regarding the content, interface design, and the data security of mHealth applications used as patient education tools. In this study, five perinatal mHealth applications providing information were evaluated by nine women's health professionals using the Healthcare Smartphone Evaluation Tool (HSAET). The scale includes 23 evaluation items related to content, interface design, and security factors. Developers of the HSAET report a Cronbach alpha of .91 for the scale. Each mHealth app had between 2 and 6 completed reviews. Most mHealth app evaluations were rated satisfactory based on HSAET scoring guidelines. Interclass correlations estimating interrater reliability indicated some inconsistency among evaluators. MHealth applications could be useful tools to supplement patient education but healthcare providers should evaluate them for their clinical practice before recommending them to their patients.

Keywords: mobile health, smartphone, patient education, perinatal care

Perinatal mHealth Application Quality

Childbearing women are especially interested in learning about pregnancy and are motivated to engage in healthy behaviors because they believe their actions could significantly impact the health of their infants' (McBride, Emmons, & Lipkus, 2003). Because of this belief, they are likely to have many questions about their health. Women of childbearing age are a demographic likely to have a mobile device capable of accessing the Internet to seek answers to their health questions as they arise (Pew Research Center, 2015). They may also use their device to download mobile health applications (mHealth apps) created to provide pregnancy and postpartum health information. MHealth apps are software programs that often provide health information, guide or remind patients about healthy behaviors, or serve as a communication link between patients and providers (Garcia-Gómez et al., 2014). MHealth apps have become increasingly available to consumers. It is estimated that the mHealth app marketplace increased over 100% between 2013-2015 (IMS Health, 2015) and continues to rapidly grow today.

Although mHealth apps are increasingly available, little is known about their use as a patient education tool. In order to create the foundation for mHealth app research and recommendations for oversight, an analysis of available mHealth apps was undertaken. To begin this analysis, current mHealth apps that provide health information for childbearing women were evaluated (Connor, Wambach, Conley, & Manos, in review). Based on this study, researchers found that mHealth apps varied in the amount of information covered. Some mHealth

apps addressed all routine perinatal education topics recommended by the Institute for Clinical Systems Improvement (ICSI) for low-risk pregnant women (Akkerman et al., 2012) while others addressed fewer topics. This study did not evaluate the extent or the accuracy of the educational content covered by mHealth apps. While it is helpful to know the extent mHealth apps address perinatal education topics, more information is needed about mHealth apps and their ability to supplement provider-supplied patient education. Specifically, content should be assessed for accuracy, and apps should be evaluated for data security and usability. An analysis of all available mHealth apps is not feasible because the app marketplace is always changing and apps are intermittently updated. The purpose of this paper is to report findings from an evaluation of mHealth apps that best meet the educational needs of perinatal women by using the Healthcare Smartphone App Evaluation Tool (HSAET). The HSAET, developed by Jin and Kim (2015), provides a systematic method of evaluating app content, user interface, and security. Evaluators were practicing women's health professionals. This study is important because it can be used as a foundation for research about perinatal mHealth apps or as a model for future mHealth app evaluations.

Background

MHealth apps are different from websites. Websites are visited while mHealth apps are downloaded. When downloading an app, a user installs it to their device. Once downloaded, the app becomes a part of an individual's library of tools. It becomes an easily located resource with content based on topics of interest. Having a readily available resource is useful, however, in the case of

mHealth apps it is concerning because of lack of regulation. Currently, the US Food and Drug Administration (2015) requires apps used as medical devices to diagnose or treat patients to be regulated, but not mHealth apps used to inform. Given the enormity of the mHealth app marketplace, this is understandable; however, healthcare professionals are concerned about the quality of mHealth apps (Wilcox et al., 2015). According to the IOM (2001), efforts to improve healthcare quality should include strategies to ensure safe, effective, patient-centered, timely, efficient, and equitable care. These features should be a part of all facets of care, including patient education materials. Currently, patients are comfortable accessing and using mHealth apps but providers may not be comfortable recommending them as an education tool because there are no clinical guidelines or required regulation. This produces a disconnect between how providers educate patients and how patients seek information.

Recommendations for consumers to obtain quality electronic health resources include seeking tools that provide accurate, up-to-date content in a usable format that protects personal health information (HealthIT.gov, 2013). It is critical to have accurate information in a patient education tool because patients make decisions based on information received. Yet, little is known about the accuracy of mHealth app content used for patient education and patients may not be able to differentiate between accurate and inaccurate information. In addition, content should be in a usable format so that patients can find and use what they are looking for. Useable formats include interface designs that are strategic, consistent, purposeful, and clear (US Department of Health and Human Services,

2017). MHealth apps should have a user interface that helps patients navigate and find desired information.

Finally, it is recommended that patients use educational tools that protect health information. Health information has unique risks in an electronic environment. Health data is more valuable to thieves than credit card information because it can be used for a variety of identity theft scams (Humer & Finkle, 2014). In an effort to minimize these risks, security measures should be in place to protect the confidentiality and privacy of personal information.

Privacy of health information means that information can only be shared with the patient's permission or if the laws allow (Harman, Flite, & Bond, 2012). Confidentiality related to health information means only authorized individuals have access to the information (Harman, Flite, & Bond, 2012). MHealth app security concerns include transmission of unencrypted data and the use of third party services such as cloud storage without obtaining permission (He, Naveed, Gunter, & Nahrstedt, 2014). These concerns raise questions about data confidentiality, privacy, and could put a person at risk for identity theft. Unfortunately, patients may not seek information about privacy or confidentiality before using an mHealth app. However, if providers are going to recommend specific mHealth apps to their patients, they should review information about the apps privacy and confidentiality features and policies to minimize risks to patients.

For mHealth apps to be clinically useful, information must be accurate and relevant. In addition, mHealth apps must be created so the information is

accessible and meets patients' needs and expectations. Healthcare providers interested in mHealth apps as a patient education tool should evaluate them before recommending them to patients. When evaluating mHealth apps to recommend as a patient education tool, content accuracy, user interface design, and health information security features should be assessed.

Literature Review

Pregnant and postpartum women have mobile devices and use them to access electronic health resources, including mHealth apps, during their pregnancy (Asiodu, Waters, Dailey, Lee, & Lyndon, 2015; Wilcox et al., 2015). In addition, women access these resources frequently. Asiodu et al. (2015) found women used mHealth apps or social media at least weekly. Wilcox et al. (2015) reported women had positive experiences using apps for pregnancy related information. Interestingly, researchers conducting a randomized controlled pilot study found women who used an mHealth app journal to record pregnancy experiences and questions for their provider versus women who used a spiral notebook for the same purpose were more likely to have their questions available to review during prenatal visits and were more likely to rate care from their provider higher (Ledford, Canzona, Cafferty, & Hodge, 2016).

Although mHealth apps are commonly used by childbearing women, both women and their providers have concerns about the responsibility for quality in mHealth apps (Wilcox et al., 2015). Quality concerns are not exclusive to mHealth apps. Health information on the Internet for pregnant women often contains misinformation or lacks important content (Wiener &Wiener-Pla, 2013).

Patients who have limited health literacy levels and who have adequate health literacy levels both access the Internet for health information (Gutierrez et al., 2014). However, all patients report relying on their healthcare providers for information (Gutierrez et al., 2014). Given that patients rely on their healthcare providers, providers may be able to guide patients toward trustworthy mHeatlh apps by providing recommendations in the clinical setting.

Methods

In a previous study, mHealth apps supplying perinatal health information were located by searching the Google Play™ and iTunes® app store using the search term pregnancy (Connor et al., 2018). Available apps were evaluated to determine the extent the educational content provided in the app included health topics recommended by the ICSI for low-risk perinatal women throughout their pregnancy. Five apps that best included recommended educational topics were selected for further review by expert reviewers using the HSAET. The mHealth apps included in this review were Mayo Clinic on Pregnancy by Mayo Clinic, My Pregnancy A to Z Journal by the Center for Excellence, Sprout Pregnancy by Med Art Studios, I'm Expecting Pregnancy Help by MedHelp Inc Communications, and Pregnancy to Parenthood by Customized Communications. Expert reviewers who were practicing women's healthcare professionals were emailed by the researcher and asked to select and review two of the five mHealth apps. Evaluations were collected anonymously using an online survey tool (Qualtrics, Provo, UT).

The HSAET scale is used to evaluate apps for quality using 23 items in subscales related to content, interface design, and security. The items are consistently formatted using positive language throughout the survey. Consistency in survey items leads to less methodological artifact and less ambiguity in results (Roszkowski & Soven, 2010). Nine subscale items evaluate content. An example of a content item on the HSAET is "Professional healthcare information is provided." Eleven items evaluate interface design factor. A user interface item on the tool is "The app has coherence in terms of color, configuration, and expression method." Three items evaluate security. An example of a security item is "The app offers information about privacy protection." During scale testing, the three subscales demonstrated internal consistency reliability with high Cronbach alphas of .84, .89, and .87, respectively and a Cronbach alpha of .91 for the total scale, indicating high reliability (Jin & Kim, 2015). Each item is responded to with a rating scale of 0 = Not at all, 1 = A little, 2 = A fair Amount, and 3 = A lot. The total sum of scores from the 23 items indicates app quality (possible range of 0 – 69). An app is "satisfactory" if the score is between 47-69. The app is considered "average" if the score is between 24-46 and "poor" if the score is between 0-23 (Jin & Kim, 2015).

Scores from the app evaluations were individually summed and assigned an app quality rating based on HSAET guidelines. A mean from all 18 mHealth app reviews was computed along with an Interclass Correlation Coefficient (ICC). ICCs provide an estimate of the consistency and agreement between raters (Laschinger, 1992). For this study, ICCs were calculated based on a one-way

ANOVA because each app was evaluated by a different random set of possible raters. This model is considered the most conservative estimate of ICC because rater effects are part of the error term and raters do not evaluate all subjects (i.e. apps) (Laschinger, 1992). ICC values with 95% confidence intervals (CI) were calculated using SPSS version 23.0 [Computer Software]. ICC values were interpreted using the guidelines >.9 is considered excellent, >.75 is good, >.5 is moderate, <.5 is poor (Koo & Lee, 2015). A mean rating and ICC for the content, interface design and security subscales based on all app evaluations was calculated. For each mHealth app evaluated in this study, individual evaluations were used to calculate a mean HSAET rating and ICC, along with the mean rating for the content, interface design, and security subscales.

Results

Eight registered nurses and one certified nurse midwife from three geographic regions of the United States responded to the email soliciting expert reviewers to evaluate perinatal apps. Eighteen mHealth app reviews were obtained. Data for each evaluation were summed and assigned a score according to the HSAET guidelines. The mean HSAET rating for all 18 mHealth app evaluations was 55.2 with a score range of 37-65. Seventeen mHealth app evaluation scores were deemed satisfactory based on HSAET guidelines. One mHealth app evaluation was classified as average. Across all 18 evaluations, the mean rating of content, interface design, and security subscales were 2.53, 2.51, and 1.69 respectively. Each subscale had a rating range of 0 to 3.

The Mayo Clinic on Pregnancy app, evaluated by six experts, had a mean rating of 58 with a score range of 48-65 (see Table 1). All evaluations of this app were considered satisfactory based on the HSAET guidelines. The ICC was .17 indicating poor interrater reliability. The subscale means were 2.79, 2.58, and 1.67 for content, interface design, and security, respectively.

The My Pregnancy A to Z Journal, evaluated by three experts, had a mean rating of 58 with a range of 55-61. While all evaluations of this app were considered satisfactory, the ICC was .14 indicating poor interrater reliability. The subscale means were 2.74, 2.39, and 2.78 for content, interface design, and security, respectively.

Sprout Pregnancy was evaluated by four reviewers and had a mean rating of 52 with a range of 49-52. All evaluations were satisfactory while the ICC was poor at -1.25. The mean ratings for the content, interface design, and security subscales were 2.27, 2.55, and 1.16, respectively.

The I'm Expecting Pregnancy Help app was evaluated by three reviewers. The mean rating was 51. The range was 37-63 which, according to the HSAET, two evaluations were satisfactory and one was average. The ICC for this app was .89, indicating good interrater reliability. The content subscale mean evaluation score of was 2.79, the interface design mean rating was 2.45, and security subscale mean rating was 1.33.

The Pregnancy to Parenthood app was reviewed by two evaluators. The mean rating was 53 with evaluation scores of 47 and 58. The interrater reliability

was good at .74. The content subscale mean was 2.44. The interface design subscale mean rating was 2.50. The security subscale had mean rating was 1.00.

Overall, mHealth apps were generally satisfactory based on expert reviews using the HSAET guidelines. The mean ratings were high for the overall evaluations but the interrater reliability was inconsistent. The content and interface design subscales mean ratings were favorable for each of the apps. However, the security subscale mean ratings were consistently lower than the mean ratings for content and interface design in all apps except one.

Table 1

mHealth App Expert Review Ratings and Interpretation Using the HSAET

mHealth app name	Number of Reviews	Mean Rating	Range of Ratings	ICC	Mean Rating for Content Items	Mean Rating for Interface Design Items	Mean Rating for Security Items
Mayo Clinic on Pregnancy by Mayo Clinic[a]	6	58	48-65	.17	2.79	2.58	1.67
My Pregnancy A to Z Journal by The Center for Excellence[a]	3	58	55-61	.14	2.74	2.39	2.78
Sprout Pregnancy by Med Art Studios[a]	4	52	49-52	-1.25	2.27	2.55	1.16

(continued)

Table 1 (continued)

mHealth app name	Number of Reviews	Mean Rating	Range of Ratings	ICC	Mean Rating for Content Items	Mean Rating for Interface Design Items	Mean Rating for Security Items
I'm Expecting Pregnancy Help by MedHelp Inc[b] Communications[c]	3	51	37-63	.89	2.19	2.45	1.33
Pregnancy to Parenthood by Customized Communications[c]	2	53	47-58	.74	2.44	2.50	1.00

a = available on iTunes® and Google Play™; b = available on Google Play™; c = available on iTunes®

Discussion

The mHealth apps were selected for this review because they addressed most of the recommended educational topics for low-risk pregnant and postpartum women. Based on the ICSI recommendations for routine prenatal care, the mHealth apps included in this study should meet the educational needs of childbearing women and could be used to supplement perinatal education received during low-risk perinatal care appointments. The consumer popularity of the mHealth apps selected for this study was not assessed by the researcher. In addition, this study did not evaluate mHealth apps that address fewer educational

topics. Further research should be done to evaluate apps that address fewer education topics to determine if they meet patients' educational needs.

This study, supports the potential of the mHealth apps evaluated to supplement patient education covered in the clinical setting because they were found to be satisfactory by practicing healthcare professionals using the HSAET. However, the interrater reliability showed significant variability. It could have been because the apps contained so much information each evaluator had a different experience accessing content to evaluate or it could have been that the reviewers come from practice settings that value different educational components. Further research could be done using a larger number of evaluators to better determine evaluation reliability.

The mean ratings for the content subscales were consistently high for all the apps reviewed. This is important because it indicates the information provided is accurate and understandable. The interface design subscale mean ratings were also high. This indicates effective design by app developers as assessed by study evaluators. These are important findings for clinically relevant educational tools. The information they provide must be accurate and provided in a format that is functional for patients to access.

The most concerning element of this study is the low mean ratings given to apps on the security subscale by study evaluators. The mean ratings for all but one of the apps on this subscale was between 1 and 2 indicating responses ranging from "a little" to "a fair amount." This is concerning because health information is a lucrative target for thieves who use the information for identity theft (Metzger &

Miller, 2016). It may be difficult for app developers to adequately explain security information within an app format. Kotecha et al. (2017) developed atrial fibrillation (AF) apps for patients and healthcare providers as part of a collaboration between the European Society of Cardiology (ESC) AF Guidelines Task Force and the CATCH ME Consortium, and the European Heart Rhythm Association (EHRA). The apps were developed to provide education, encourage behavior change, and promote AF treatment guidelines. The development team included clinicians and app developers. Interestingly, when the AF apps were evaluated using the HSAET tool, all items except the interface design item "visual elements do not confuse users" and the security subscale item "the app offers information about privacy protection" scored a 3 while these two items scored a 2. It is not clear why scores tend to be lower on security subscale items. It could mean that security information within apps lack transparency, are confusing to reviewers, or is not available.

Because security is a growing concern and the literature is scant, further evaluation of mHealth app security should be conducted to determine the extent of the mHealth app security issue. Guidelines should be offered to app developers regarding the importance of protecting patient data and clearly presenting privacy information. Finally, further research should be done to determine perceptions providers and patients regarding mobile security to determine their consumer evaluation practices and what people need to learn about digital security.

Limitations

This evaluation was limited to a small number of free mHealth apps that serve to educate childbearing women about perinatal topics. The apps selected for this study were limited to apps that covered most, if not all, of the recommended educational topics for pregnant or postpartum women. The evaluations were completed by a small number (nine) of women's health professionals. Based on the limited scale of this study, it is unknown if there is a difference in apps based on the amount of educational content provided or if a larger group of women's health providers with different backgrounds would change the results of this study. Future studies could be conducted by evaluating perinatal mHealth apps that cover differing amounts of mHealth information, comparing mHealth apps from well-known organizations with those from unknown sources, comparing free mHealth apps with paid apps, and by increasing the variation in types of women's health providers that evaluate the apps.

Conclusions

Women who are pregnant or who have delivered should regularly see a healthcare provider for routine care. During these visits, providers screen for risk, promote healthy behaviors, and provide information about healthy behaviors. Although teaching is done during office visits, patients may have additional questions or concerns in between appointments. MHealth apps may be useful tools to supplement health information received during routine perinatal care appointments. However, literature regarding perinatal mHealth apps is scant, the

mHealth app field is continually evolving, and the quality of mHealth apps supporting pregnancy is unknown.

Using the HSAET tool, evaluators were able to systematically assess five perinatal apps. The HSAET tool could be used by healthcare providers interested in recommending apps to patients in their clinical practice. However, healthcare providers should keep in mind that security features within apps could be lacking and may leave patients' information vulnerable. Providers should not simply stop discussing apps with their patients, because patients are using them on their own. Rather, it is an opportunity for providers to steer patients toward apps with stronger security features and away from apps that do not have them.

Results from this study highlight the need for further research and possible oversight into the development and use of mHealth apps. The research and use of mHealth apps in clinical settings is an emerging field. This study did not assess the perceptions of women who use the apps for health information or the educational outcomes of women who used these apps. Research should be conducted to evaluate perinatal apps on a wider scale, to evaluate mHealth apps geared to different populations, and to determine behavior changes resulting from knowledge obtained. MHealth apps from trustworthy sources with accurate content should be promoted to patients. Patients and providers should be educated about security risks in mobile devices. Guidelines should be developed to create apps that better protect health information.

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Chapter 4

Connor, K., Wambach, K., & Baird, M. (2018). Mobile health applications for perinatal health information: A descriptive qualitative study of women who use them. Manuscript submitted for publication.

This manuscript has been submitted to *Journal of Obstetric, Gynecologic, and Neonatal Nursing* and provides a qualitative description of the perceptions of women who used mHealth apps during their pregnancy and after delivery. The manuscript was co-authored by Karen Wambach, PhD, RN, and Martha Baird, PhD, RN.

Abstract

Objective: To determine the extent perinatal mobile health applications are useable and desirable for women seeking health information about childbearing. **Design:** A descriptive qualitative research design. **Setting:** Participants were recruited from the social media sites Craigslist, Nextdoor, and Facebook. Study participants were asked to recruit friends to participate in the study using a snowball sampling technique. **Participants:** Sixteen pregnant or postpartum women who used mobile health apps participated in the study. **Methods:** Semi-structured interviews were conducted to determine how participants perceived and used applications for pregnancy information. Participants were then given a perinatal app and asked to find specific information using a think-aloud process. *Data were coded into meaning units, coded, and then organized into concept maps. Concept maps were organized in an iterative process until themes emerged.* **Results:** Three themes emerged from the data. First, women find support from mobile health apps because the information received is personalized to them and because they can connect with family and the online community through their apps. Second, mobile health apps are functional tools for perinatal women. Finally, mobile health applications have perceived limitations because women sometimes feel disconnected from the information they receive, some providers and families do not support app use, and security issues may be a concern. **Conclusion:** Mobile health apps can be a useful patient education tool. Providers can support patients by recommending select apps to them. Because of minimal

oversight in the development and use of mobile health apps, a system to certify or verify health care apps should be developed.

Keywords: mobile health applications; perinatal; patient education

Mobile Health Applications for Perinatal Health Information: A Descriptive Qualitative Study of Women who Use Them

Mobile health applications (mHealth apps) are software programs that are downloaded onto a user's device designed to perform a specific health related task or function (Aungst, Clauson, Misra, Lewis, & Husan, 2014). Examples of mHealth apps include apps that provide information, track data over time, or serve as a communication link between patients and providers. MHealth apps have been developed to promote health for the general population and for patients with specific health conditions, such as pregnancy. Pregnancy related mHealth apps are searched for by patients more than apps for any other health condition (Tseng, 2016). Reasons could be that childbearing women are likely more comfortable with technology, there are significant physiologic changes during pregnancy, and childbearing women often seek information and guidance (Tseng, 2016).

Although mHealth apps can be created to provide many functions, they are limited by the size of mobile screens (Nielsen & Budiu, 2013). Designers of mobile apps must strategically plan for how the user will access and navigate content. Content delivered through a mobile app must be condensed to avoid extraneous information and to minimize scrolling to find information. Because of screen size limitations, information must be presented in a succinct format to be read easily on a mobile device (Nielsen & Budiu, 2013).

Because mHealth apps are downloaded onto a user’s device, they are more directly accessible to users than a website. Often, mHealth apps for childbearing women are set to provide information based on the woman’s due date. In addition,

many pregnancy-related mHealth apps send users periodic emails about their pregnancies. Because of the succinct information format, the individualized information provided based on a woman's due date, and the addition of emails directing women towards app content, mHealth apps may be an effective strategy for providing perinatal education using current educational pedagogy.

In order to promote learning, effective instructional design strategies should be used (Van Merriënboer & Sweller, 2005). According to the Cognitive Load Theory (CTL), learners can only process a finite amount of new information at one time because working memory has a limited capacity (Van Merriënboer & Sweller, 2010). Cognitive overload results when new information is too complex and/or there is too much extraneous information. Recommendations for decreasing learner's cognitive load include providing information in one integrated source rather than many, eliminating redundant information (Van Merriënboer & Sweller, 2010), allowing learners time to process new information, and including multiple learning elements such as words, pictures, and videos to support individual learners (Mayer, 2010). MHealth apps may be useful tools for providing small amounts of information on a regular basis to promote learning and prevent cognitive overload.

During pregnancy and the postpartum period, women are encouraged to seek regular perinatal care. The purpose of routine perinatal care for low-risk women is to identify risks and to provide information on healthy behaviors and when to seek the provider for care. Perinatal education includes information on several different topics such as nutrition during pregnancy, signs of preterm labor,

or when to call the provider. Because many different educational topics are presented during perinatal appointments, a woman may feel cognitive overload and may not be able to retain the information provided. MHealth apps may be useful for supplementing patient education provided during perinatal education appointments. However, information about mHealth apps as a patient education tool in the perinatal setting is limited. The purpose of this study was to determine the extent mHealth apps are considered desirable and usable for pregnant or postpartum women seeking information about childbearing. Based on the findings from this study, recommendations could be made for clinical use and the development of future perinatal mHealth apps. In addition, findings may also assist researchers, app developers, and health care providers interested in the use of apps for other patient populations.

Background

The Health Information Technology Acceptance Model (HITAM) was used as a conceptual model to develop interview questions for this study. According to the HITAM model, individuals are motivated to seek health information technology (HIT) tools, such as mHealth apps, when they have a health concern and have normative beliefs or social influences that lead them to believe the HIT tool will be useful (Kim & Park, 2012). In addition, a patient's HIT self-efficacy and beliefs about the reliability of a HIT system impact their HIT system attitudes, intended behaviors, and ultimately, their behaviors (Kim & Park, 2012).

Research has been conducted on the use of mHealth apps in the perinatal setting but there is not enough information to provide a solid foundation for research. Studies have not shown that birth outcomes are better for women who used apps than those who did not (Choi, Lee, Vittinghoff, and Fukuoka, 2016; Ledford, Canzona, Cafferty, & Hodge, 2016). One study found that women who used an mHealth app journal instead of a spiral notebook journal during pregnancy were more likely to have their app journal with them during perinatal office visits and rated the communication with their provider higher during their pregnancy than women who used a spiral notebook journal (Ledford et al., 2016). Based on the literature reviewed, most perinatal women have a device capable of downloading mHealth apps (Asiodu, Waters, Dailey, Lee, & Lyndon, 2015; Ledford et al., 2016; Wilcox et al., 2015). They are comfortable with apps and require minimal instruction in how to access and use them (Asiodu et al., 2015; Wilcox et al., 2015). These findings are consistent with the Pew Research findings that most women of childbearing age in the United States have a mobile device and are able to use it to access the internet (Pew Research Center, 2015). Based on this information, providers can be comfortable that most patients in their practice will be able to access recommended mHealth apps.

Methods

Research Design

A qualitative descriptive design was selected for this study because little is known about how women use mHealth apps during pregnancy. Qualitative

descriptive studies are useful when little is known about a phenomenon and a description is desired (Sandelowski, 2000).

Recruitment

Participants were recruited from a community in the Northwest United States through the social media platforms Craigslist, Nextdoor, and Facebook and by asking participants to recruit others using a snowball sampling technique. Eligibility criteria included women over age 18 who were pregnant or who had given birth within six months. Participants had to have used an app for information during childbearing and were able to speak and read English. This study was approved by Boise State University's Institutional Review Board (IRB) with an authorization agreement from the University of Kansas Medical Center's IRB for Boise State's IRB to provide study oversight.

Data Collection

Demographic information was collected using a demographic information survey form completed by participants. Semi-structured interviews were conducted by the primary researcher using an interview guide created for the study. The interview guide consisted of 28 questions about how mHealth apps were used during the perinatal experience. Examples of interview questions were

1. Tell me about your experience using apps to learn about your pregnancy or your baby?
2. What do you like best about using apps for pregnancy information?
3. When you wanted more information on a topic than was available, what did you do?

In addition, a think-aloud method was used to perform usability testing (Nielsen, 2012). At the end of the interview, the researcher opened a perinatal app for each participant and asked them to use the app to locate information about breastfeeding and preterm labor while they described what they were doing and thinking as they located the information. This approach to usability testing allows the researcher to observe actions while participants provide insight to their decision-making (Nielsen, 2012). The think-aloud process was used to observe how the participant navigated a mHealth app and to hear what the participant liked and found challenging about it.

Data Analysis

Interview sessions were audio recorded, transcribed verbatim and shared by secure email to the research team. Data were analyzed using a process adapted from Colorafi and Evans (2016); original text was separated into segments or meaning units that contained single ideas. These meaning units were condensed and codes that captured the ideas were applied. Coded data were organized into a concept map to allow the researchers to identify patterns. The codes within the concept map were organized, condensed, and compared to original codes and meaning units in an iterative process by the members of the research team to developing themes. At the completion of the study, an independent qualitative researcher reviewed study transcripts and the data analysis process to authenticate findings and enhance dependability through an inquiry audit technique (Lincoln & Guba, 1985).

Validity and Rigor

Data were collected until saturation was reached. Confirmability of findings was obtained by triangulating interview data with the data obtained through the think-aloud usability testing and by verifying findings with a subset of original study participants. These efforts promoted rich variation in the data, thus enhancing credibility in the findings (Graneheim & Lundman, 2004). Dependability of findings was enhanced by research mentors guiding the development and implementation of the study and supporting the data analysis and interpretation of results and by the independent qualitative researcher verifying findings. Transferability was enhanced through detailed description of the research methods and findings.

Results

Sixteen women participated in this study (Table 1). The median age was 31.9 with a range of 23 to 41 years. Four were pregnant at the time of the interview. Four participated were first-time mothers. The multiparous participants in this study had delivered between 2 and 10 children. One participant had delivered twins and another was pregnant as a surrogate. Thirteen participants (81%) were Caucasian, fifteen (94%) spoke English as a first language, and twelve (75%) were employed. Three participants (19%) had at least some college, 11 had a bachelor's degree (69%), and two had a master's degree (13%). Nine participants (56%) had gone to childbirth education classes with at least one of their pregnancies. Participants were asked to rate their comfort using the internet from 0 = not comfortable to 10 = extremely comfortable. All participants rated

their comfort level 8 or higher. All the participants had smartphones capable of downloading apps and used the Internet to find health information.

Table 1

Descriptive Characteristics of Participants

	Frequency	Percent*
Ethnicity		
White	13	81
Hispanic	1	6
Asian	1	6
Other	1	6
Education		
Some college	3	19
Bachelor's degree	11	69
Master's degree	2	13
Employed	12	75
Pregnant at the time of study	4	25
Delivered at the time of study	12	75
Number of children		
1 child	4	25
2 children	5	31
3-5 children	4	25
6 or more children	3	19
Previously attended childbirth class	9	75

**Percentages may not be equal to 100 due to rounding.*

Three themes were identified in this study. The first theme was that mHealth apps are a source of support during childbearing. The participants reported that they received informational support from the apps, family members supported them by using perinatal apps to follow the pregnancy, and they also received support from the online community from the message boards they accessed through the app. The second theme was that apps are functional tools for meeting informational health needs. Apps were functional tools during pregnancy because information was personalized to each woman, was accessible and interactive, and the apps could be used to track the pregnancy. Finally, the third theme was that although there were benefits to using mHealth apps, there were limitations to be considered. The apps might lack functionality, information may not be relevant, women may receive negative messages about using apps during pregnancy, and the security of apps may be questionable.

mHealth Apps as a Source of Support

Participants of this study described the support they received for their childbearing experience because of using mHealth apps.

Information as a source of support. Most perinatal apps require users to enter an estimated delivery date into the app so information the user received was specific to the gestation of the pregnancy or the age of their infant. In addition, health promotion information could provide anticipatory guidance. Participants in this study found the information received from apps to be supportive because the information was specific to their needs.

The participants felt that information was personalized to them. One woman described her experience as follows, “they [the app] would bring up what I was thinking about like they knew what was happening at that time or something and it just seemed really validating.” Another woman stated, “I have been having Braxton-Hicks [contractions] gosh since like week 25 or 26, something like that. So, this last week, they said common symptoms [were] Braxton-Hicks. So, I thought, okay, so now it’s normal.”

Participants liked to be able to receive and look up information, even if they had children before: “This is baby 11… but I like to learn. People say, you’ve had babies before, but it is like every pregnancy is different. Sometimes I have individual things, like something will come up. I have never experienced this.” Another woman explained, “I have two boys and now I have a girl, my pregnancy was completely different this time. I was like, okay this is new for me, so I tended to be on a little bit more. I had way different symptoms.”

Connection with others. Positive social connections between participants and others was often expressed in this study. Several participants explained that family members used perinatal mHealth apps on their own devices in order to share in the pregnancy. One woman said, “my mother-in-law…did her own app for me on her phone so then she knew what I was going through.” Another reported, “my husband could actually download it too and put in my due date and it had articles for fathers in it for him too, so, he knew.” Another participant explained,

> I know he (her husband) downloaded the *Glow* app and there was another one that was, it's like, *Pregnancy for Dads*, or something like that… there are times when he'll come up to me and say, 'did you know that she can see now? She can open her eyes.' Or, ... he came up to me and said she's 29 weeks today.

Although apps can serve as a connection, some people may be hesitant to download apps for pregnancy information. "My husband really likes it [the app] and he wants to install it so he can learn about the pregnancy." However, "he didn't install it because he felt weird (because he is a man)."

Another woman carrying a surrogate pregnancy was asked to use an app with a journal feature for the think-aloud portion of this study. Her thoughts were that she could connect with the baby's parents with the journal.

> It might be nice for surrogacy just to say these are my thoughts for today. You are going through a different process because it's not your child so you're trying to separate yourself from that and yet still feel excited because it's still a child in your stomach and you're still bonding. It is interesting to write different experiences. …I could say, 'today I'm feeling really nauseous. The baby is really moving.' And then, if they were to read that, I'm sure they'd really love that. I never thought about that.

Support from Online Community. Some perinatal mHealth apps have online message board features where users can ask and answer questions or read about the experiences of others. Message boards were polarizing in this study.

Some participants stayed away from the message boards because they tended to be controversial. *As one participant explained about message boards,*

> *There is always someone coming one saying 'oh, I am going to do this for my pregnancy' and it starts a chain reaction. The big ones are circumcision and vaccination. It is the pot-stirrers and they get in there and it is like, 'okay, how many comments can I get in this.'*

Other participants reported that they liked and gained support from message boards. Two participants in this study explained that they did not have any friends or family members who were pregnant so they liked to talk to other pregnant women about their experiences. They found support on online message boards they connected to through their perinatal apps. One woman said,

> I liked the message boards, I liked the emails that I would get weekly from it…because like I said, with the Baby Center App, you have what they call the birth boards. Everybody's due [at the same time]. This is when they were due, in the group, everybody was there. I would mostly go into the one with the birth club, so it was mostly people around my due date.

Another woman explained how community message boards can be supportive throughout the perinatal period,

> The social part is there when you're pregnant and its like, 'Hey, how is everybody doing?' You know, bump pictures and things like that. Then, when it's all said and done, it's like, okay, 'who's not getting any sleep? Or who's having issues here or my baby has heart problems and is going to have to go to surgery. Does anybody have any experience with this?'

Another participant explained her desire to use the message boards as follows: “I tend to go in to kind of the conversational part, like the real mom part and kind of what they can tell each other. I am looking for, does anyone have a similar experience like I do? And those kind of things, that's what I look for.” For another mother, a message board might be a part of how she found answers to questions. She explained,

> The discussion board…. if I had like a problem I would usually look it up sometimes and the discussion boards might have it and so it would be interesting because other people are going through the same thing you are going through. So, it was nice in that way but yes, it can cause you to be a little bit on the...oh, this went wrong and that could happen to me.

mHealth Apps as Functional Tools

Fifteen of the 16 women reported accessing their mHealth app at least weekly. Most women used free apps to access information because it fit their needs and was informative. They found apps easy to use, appreciated their interactive features, and found them to be trustworthy and convenient. Some participants described downloading several apps to compare the information between them. When they found the information to be similar, they believed the information to be trustworthy. Several participants reported not questioning the information provided. Another participant explained that she trusted the information provided because it was written by a doctor and she could look them up if she wanted to. One woman explained the convenience of using an app rather than the internet for information,

> When I use Google, I have to go to my browser, and I have to type it in, and I have to look which one I want, when I can go to the app and I can just get to which one I am looking for. It is already the information I need.

Most women did not pay for the apps they used. They like the availability of interactive features such as contraction timers and kick counters in apps but they often reported not using them. As one woman explained, “I won't use that. I mean if I had a history of maybe a miscarriage or high-risk something I would probably use it but I'm not high anxiety either. I have no doubt that this kid will be fine.”

Many study participants used perinatal apps to track their pregnancy, however, they tracked in different ways. Some used apps as a digital scrapbook where photos could be uploaded and stored. Others used the app to countdown their pregnancy. Still others used them to enter health information. One woman reported using an app to track her infant’s feeding, she said

> I was having a lot of trouble with pumping. Still to this day, I have to supplement and pump… I was talking to lactation. I was talking to them every day and I would show them my log and I was like ‘this isn’t working or it’s not working, what else could I be doing?

However, some women tracked data in case they needed to discuss it with their provider, but because they had a normal pregnancy, they never did. As one woman explained,

> I kept it mainly in case like I had to bring up information to my doctor. Like, 'oh, a week ago I was feeling cramping around this time' or something. So that was mainly why I kept up with it.

Limitations of mHealth apps

Although all participants were users of mHealth apps during pregnancy, they did describe limitations or barriers to using them. Women reported experiencing apps that did not work well or that provided them with information that was irrelevant, questionable, or limited. When women did not like the functionality of the information in an app, they deleted it from their personal device.

> If it's too complicated, I'll probably just take it off. I'm not going to spend a lot of time. To me I always think [an] app should be simple that's the point of them. It's just they should be a quick and sweet give me what I need and if it's not that way and if it's too complicated they'll be gone.

Other limitations were that they felt disconnected from information provided in the app. One woman reported feeling guilt over not being able to do the healthy behaviors recommended in the app.

> With drinking the water… you have to drink a lot of water throughout pregnancy. I couldn't so it makes me feel guilt about if I cannot reach the goal. If I cannot reach the goal…It is like they tell you to drink like 8-12 cups a day and it is so hard… I feel like I have to do whatever they recommended.

Another participant felt frustrated about the tone of the information she received.

> I know it sounds weird but this daily tip or week or something…for somebody who is very sick, it's all happy and go lucky and it's just like it is all going to be great and you're just moving along. It just seems so disconnected… Sometimes they do that like 'oh, you can take a walk' and I'm like, I can't walk.

A third participant described the stress she felt when she was having a threatened miscarriage and the app was sending her pregnancy information, "I used [the app] *What to Expect* right when I first found out I was pregnant, but I had a subchorionic hemorrhage and I thought I was miscarrying, so then I deleted that app…"

Lack support for apps. Unlike the ideas from theme 1, here some participants felt their mHealth app use was not supported by healthcare workers or by some family members. One participant who delivered premature twins who spent several weeks in the neonatal intensive care unit was frustrated when she asked staff for infant tracking app recommendations. She said,

> At the hospital I was asking some of the nurses, who I figured would talk to people about which apps do people use, and the ones I talked to didn't really know. So, mostly, mostly it was just, trial and error that I found what I did.

Another participant was told by a family not to use apps during pregnancy. The participant said,

> My grandma didn't really like it because she said that I shouldn't rely on that kind of information unless it was coming straight from the doctor. I was pretty sure that it [app information] was written by nurses and doctors and not just some lady sitting at her home who created an App but she didn't really like that idea.

Security concerns. Most women were not concerned about app security. Of those who were concerned, the common fear was of exposure of personal information on the internet. As one participant explained,

> I was concerned about my pregnancy information and if they were sharing it. I didn't know how private it really was. Cuz [sic], it said that Facebook could access this [the app] and I was like, I don't really want people to know that I'm pregnant yet.

Some women reported their strategies to protect their information by saying, "I wasn't going to post anything that it would come back and somebody would know it was me." Others reported trying to find reliable sources or entering false information into the app.

> I am trying to find something like based on reliable sources, kind of reliable. So, if it has a book published, I am like, Okay, I feel comfortable using those. Some third-party, those kind of app, make me a little nervous. I used contraction counter app and also a breastfeeding counter app. I feel so uncomfortable, I put in a dummy date [estimated delivery date].

Discussion

Providers educate women about pregnancy during perinatal office visits, however, the number of perinatal visits are limited as is the amount of time that can be spent with each patient. Perinatal mHealth apps can be tools to reinforce teaching, support the patient, and provide information frequently to reduce the cognitive overload of patients. Decreasing cognitive overload may increase learning and help patients differentiate between expected changes in pregnancy and those that should be evaluated by a provider. The purpose of this study was not to seek the best app for perinatal women but to evaluate the perceptions of women who used mHealth apps in general, during and after their pregnancies to better understand how providers could support patients through the use of mHealth apps and so app developers could improve their products. Participants felt supported by apps because information was personalized to them based on their due dates. They liked the convenience of receiving information on their mobile devices but they used different apps on these devices and liked different features within the apps. If women did not like an app, they deleted it from their device. Asiodu et al., (2015) also found women deleted apps that did not meet their expectations. Because different women like different features, providers should recommend more than one app to their patients to increase the chance the patient finds one that best meets her needs.

Health care providers can facilitate the support of childbearing women by recommending they download perinatal apps to follow the pregnancy or to connect with others. Pregnancy is a state of eustress and having friends and family

to talk to about her experience may be helpful. MHealth apps may help friends and family understand what the woman may be feeling, what changes to anticipate, and how the baby is developing. Women who do not have pregnant friends or family to talk with may find support from mHealth app message boards but it is not clear how message boards are moderated or reviewed for content accuracy and providers may want to caution patients about this potential risk. Because many women track or are interested in tracking information in their mHealth apps, providers could recommend apps for counting contractions or number of breastfeeding sessions to better assess the patient. They might also suggest patients use the journal features within apps to record questions to ask during their perinatal office visits. As noted by Ledford et al. (2016), patients may perceive communication with the provider is better when information recorded in a mobile app is reviewed during office visits.

Participants in this study established trust in app information if the information was similar to other information received or if it appeared to be from a reputable source. While these methods of establishing credibility are reasonable, providers should dialogue about app information patients receive, recommend reliable mHealth apps from reputable sources to their patients, and periodically review the app content of apps they recommend to their patients for content accuracy.

Some participants in this study were concerned about mHealth app security. Security concerns included the apps posting about their pregnancy on social media before they were ready to disclose, being identifiable in their online

message board posts, and the discovery of their actual due dates; slightly altering personal information made them feel more secure. This is concerning because personal information from a mobile device can be stolen through unsecure Wi-Fi, flaws in the security of a device, and from malicious code designed to steal information written into and hidden in apps (Schlesinger & Day, 2016).

To minimize security issues, providers should recommend mHealth apps created by a reliable source such as Mayo Clinic, Web MD, or Center of Excellence for Medical Multimedia and downloaded from an app store platform rather than a website (Schlesinger & Day, 2016). However, the issue of app security is a significant issue for patients and providers. App store platforms are not able to verify the security of every app. Patients and providers are limited in how they can evaluate app security. The mHealth app marketplace continues to grow with more and more apps becoming available. A recommendation to improve mHealth app security is to develop an organization or a certification process where mHealth app developers can submit their app for review and if they meet criteria for content accuracy and security, the app receives a seal of approval or a recommendation. This organization could also provide information to health care providers about mHealth apps and their clinical use. The use of mHealth apps continue to grow and will likely impact patients and providers across health care settings. An independent organization providing information would help patients and providers feel more confident in recommending and using apps.

Limitations

Women in this study chose to participate. Because they were self-selected, they may have been more technologically savvy or more willing to use technology than the general population. This study was a small qualitative study limited to participants who live in a medium-size community in the Northwest United States. A subset of participants did review and verify the findings in this study, but it is unknown at this time how well the findings reflect the experiences of women who live in other geographic areas. Because of the self-selection of participants and the geographic region where the study was conducted, transferability of this study's findings may be limited. Further research into the perceptions of women who use mHealth apps during childbearing should be conducted.

Conclusions

This study supports the use of mHealth apps as a supplement to patient education provided in the perinatal setting. Women like apps because information is targeted to them based on their stage of pregnancy, being able to access content on their mobile device, and they are able to obtain support from others through the use of apps. Future research could include evaluating how well patients learn information presented in an app format and if there is a difference in health outcomes because women used a mHealth app for perinatal health information. Health care providers interested in supporting patient education by using apps should evaluate a small number of apps for content accuracy and data security to recommend to patients. However, this is unrealistic due to the changing nature of

the app marketplace and providers lack time to evaluate perinatal mHealth apps. Because of the minimal oversight in the development or verification of informational mHealth apps, a system should be created to certify apps that meet quality and content accuracy criteria. The process could be similar to a peer review process based on established criteria, would be reassuring for patients and providers, and help reputable mHealth apps provide evidence of achieving standards.

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Chapter 5

Summary

Routine prenatal care is recommended throughout pregnancy. Initially, visits are scheduled every four weeks, increasing to weekly visits at the end of the pregnancy (U.S. Health and Human Services, 2017). Education about pregnancy changes, health promotion activities, and when to call the provider are important topics to be covered with patients during these appointments. However, because so much information is covered, patients may not be able to remember everything that was discussed with their providers.

Perinatal mHealth apps have the potential to be useful educational tools for providers to use with patients. MHealth apps are readily available, offer relevant information based on gestational age, and women are comfortable using them. However, mHealth apps are not routinely discussed in the clinical setting. It is unclear why this may be because the literature about the use of mHealth apps is limited. It could be speculated that mHealth apps may not be used because providers are not aware of the information contained in an app format, they are leery about the quality of app content, or they may be uncomfortable using apps for health information themselves. Further research should be conducted to understand provider perspectives. The purpose of this study was to discover the extent mHealth apps meet the recommended educational needs of childbearing women and to determine the extent mHealth apps are desirable and usable for pregnant or postpartum women seeking information about childbearing.

An app is “typically a small, specialized (software) program downloaded onto a mobile device” (Dictionary.com, 2017). A recent report estimated

2,800,000 and 2,200,000 apps are available on the two largest app distribution platforms Google Play™ and the iTunes®, respectively (Statista, 2017). The app industry is large and growing because anyone with an idea can become an app developer. There are several programs to assist with the design and coding of apps (Cohen, 2013). Once developed, the app is uploaded onto a distribution platform to be downloaded by users (Yargo, 2017). While it is enticing for app developers to easily create and distribute apps for mobile devices, it can be problematic for providers and consumers of mHealth apps.

MHealth apps are a small but growing subset of available apps. MHealth app genres include apps to manage chronic diseases, diagnose or treat health conditions, promote healthy behaviors, support women's health (including perinatal apps), manage medications, and serve as a personal health record (Adoriasoft, 2017). Currently, there is limited oversight of mHealth apps. MHealth apps created to diagnose or treat a health condition must be evaluated for reliability and validity but informational apps are considered entertainment and not routinely evaluated (FDA, 2015). Because of the limited oversight and the relative ease of app creation, content accuracy, ease of use, and information security could vary significantly.

As part of this study to determine the extent mHealth apps meet the educational needs of perinatal women, an inventory of available free mHealth apps and the content they supplied was conducted. A search of Google Play™ and iTunes® produced over 500 apps related to pregnancy. However, as the apps were downloaded and reviewed, most were excluded from further review because they

were off-topic or not accessible. An example of an app classified as off-topic would be a pregnancy game. An app that would have been classified as not accessible would be an app that required fees to access content. Remaining apps were retained for further analysis to determine if they included education topics recommended for low-risk perinatal women. Findings were that most of the remaining mHealth apps covered some but not all of the recommended educational topics.

These are interesting findings that highlight the need for deliberate structure in the mHealth marketplace. First, there are many apps located using the search term “pregnancy”, but most are not relevant to pregnant women. In fact, 84% of the apps located were excluded from further review because they were not relevant meaning they did not provide pregnancy related health information or information was not accessible. This may be frustrating for women interested in finding relevant health information about childbearing. It highlights the need for providers to recommend mHealth apps to their patients to save them the trouble of locating appropriate apps and to steer them toward apps from reputable sources with accurate content.

The other important finding from this study was the majority of apps that did appear to have relevant content did not have all the content that would be used for low-risk pregnant and postpartum women. For example, an app may have included information about fetal development, exercise during pregnancy, and tips for managing first trimester nausea and vomiting, but no information on maternal changes or warning signs of premature labor that should be evaluated by

a provider. This is important because it demonstrates the need for providers or professional health organizations to work in partnership with app developers to ensure accurate and appropriate content is included in the app design.

After app distribution platforms were searched for perinatal mHealth apps and an assessment was done to determine if recommended educational topics were provided in the apps, the apps that provided the most content were evaluated by expert reviewers. These reviewers were practicing women's health clinicians. Reviewers were asked to select and download two of the apps provided and evaluate them using the Healthcare Smartphone Applications Evaluation Tool (HSAET). The HSAET provides an evaluation guide to rate apps based on content, usability, and security (Jin & Kim, 2015). After all items are rated, responses are summed, and apps are assigned a satisfactory, average, or unsatisfactory rating.

Eighteen evaluations of five apps were conducted by nine reviewers. Seventeen app reviews were assigned a satisfactory rating; one an average rating and none were rated as unsatisfactory. These findings are important for two reasons. First, findings indicate that apps can be useful as an educational tool because they contain relevant content and they achieved a satisfactory rating by expert reviewers. Second, mHealth apps can be systematically evaluated by healthcare practitioners using a tool such as the HSAET.

The second phase of this study involved asking women about their experiences using apps for health information during pregnancy and after delivery. Key findings in this phase of the study were that women gained support

from others because they used perinatal apps, they liked how information felt individualized for them because the information was based on their gestational age, they trusted the information they received, and most of the women reported that their providers did not talk to them about using apps for pregnancy or postpartum.

A surprising finding of this study was that women felt supported in their pregnancy because they used an app. Several participants explained that their spouse or other family members downloaded the same app as the pregnant woman so they could follow, learn about, and discuss information about the pregnancy with them. Another participant explained how postpartum infant tracking apps can be used by multiple caretakers to track information such as the frequency and amount of formula an infant consumes over time. Other participants reported using application links to online discussion board forums to connect with other pregnant women. Many felt supported because they did not have pregnant friends or family members and appreciated the ability to discuss pregnancy issues with women in an online community.

Women reported trusting apps as sources of information because the information was congruent with information received from other sources during their pregnancy. It was noted, however, that most women do not discuss the use of mHealth apps with their health providers. This may be a missed opportunity because some women reported feeling disconnected from the information received, another woman felt frustrated that her provider could not recommend a relevant mHealth app to her, and many reported using their apps to track

information about their pregnancy and newborn. Tracked data could be clinically relevant to healthcare providers. For example, information about the frequency and duration of breastfeeding sessions tracked by a mother on an app may help the provider understand how an infant is feeding.

In summary, this study highlights the need for a process to distinguish useful or informative mHealth apps from the number of apps that are either not health related or not as extensive as they could be. This study was able to demonstrate a method of systematically assessing the app marketplace for a specific health issue. First, primary app platforms were searched, app content was compared to a list of desired patient education topics, and then apps that comprehensively included relevant patient information were evaluated using the HSAET tool.

Implications for Perinatal Providers

Patients are using mHealth apps. Based on the literature review and the findings from this study, childbearing women do not need training on how to use the app itself. They do need the information contained within an app. Apps should be evaluated by health providers using strategies described in this study to determine if information is consistent with the educational priorities within the practice. Providers could provide patients with a list of recommended apps at their prenatal appointment or they could post recommended apps on their website. Patients will then be able to self-select their favorite apps from the list of recommended apps.

Based on this study, providers should talk with patients about apps during prenatal care appointments. This could include asking if they received information on key topics and if they had questions on the information received. This allows the provider to assess the patient's understanding of the information and allows the opportunity to clarify or provide more information as needed. Asking patients about their understanding of topics instead of simply reviewing all topics may save time during the visit because providers can focus on information that is needed rather than cover all topics. Providers could ask if the women have any tracked data within the app to be reviewed. Depending on the app, tracked data may include questions for the provider, contractions, or breastfeeding logs. Asking women about their tracked data may give the provider insight into the patient's health or enhance communication between the patient and the provider. According to the findings from this study, patients use apps for health information without input from their healthcare providers. In some instances, patients look to their healthcare providers for mHealth app recommendations and are frustrated when providers are unable to provide suggestions.

Implications for Practice and Research

Guidelines for mHealth apps are important for the development of apps as a consumer health information technology tool. The app marketplace will undoubtedly continue to grow. While it is important to understand the perinatal health landscape to better serve the needs of pregnant and postpartum women for health information, understanding perinatal mHealth apps may serve as a

foundation or template for understanding and utilizing mHealth apps for other patient populations. Childbearing women are a patient population with defined health information needs. They are younger and likely more comfortable with technology than other populations may be. Understanding how childbearing women use perinatal mHealth apps may help improve the use of apps in other patient populations.

According to Tseng (2016), perinatal mHealth apps are one of the fastest growing sectors of the mHealth app marketplace. Several participants in this study downloaded and used more than one perinatal mHealth app to use for health information during their pregnancy and after their delivery. All study participants reported that they enjoyed using apps for health information and would likely use them again in the future.

In 2015, there were close to 4 million births in the U.S. (Centers for Disease Control and Prevention [CDC], 2017). The average age of a woman giving birth was 26.4 (CDC, 2017). Younger people are from a demographic most likely to own a mobile device and to look up health information on the internet (Pew Research Center, 2015). In this study, 505 apps were located using the search term "pregnancy" on Google Play™ and iTunes® and the women who shared their experiences with apps during pregnancy stated they would use apps for health information in the future.

Perinatal mHealth apps are designed for a specific population. As the mHealth app marketplace grows, so does the availability of mHealth apps for multiple patient populations. Diabetes mHealth apps is example of mHealth apps

developed for different patient population. In 2015, 30.3 million people had diabetes, and, of those, most were 45-years-old or older (National Center for Chronic Disease Prevention and Health Promotion, 2017). Currently, there are over 1,100 available apps for diabetes on Google Play™ and the iTunes® (UF Diabetes Institute, 2017). Lessons could be learned from this study to improve mHealth apps for diabetics because as the population ages, the older population will be more comfortable with using technology. Based on the findings from this study, app developers should create apps that are able to customize information for the individual user. Clinicians who care for diabetics should systematically evaluate relevant apps and discuss them with their patients. Researchers could learn more about how individuals with diabetes use and perceive mHealth apps.

While this study provided evidence for the usefulness and desirability for perinatal mHealth apps, security remains a concern. Security concerns range from accuracy of information on message boards, to embedded malware and identity theft. Because mHealth apps offer relevant information and are actively used by patients, healthcare practioners and organizations should insist informational mHealth apps be considered as more than entertainment and should adhere to developmental and oversight guidelines similar to apps classified as medical devices.

The healthcare industry has recognized and has begun to seek input on the development of mHealth app guidelines (Xcertia, 2017). With established app guidelines, developers will be able to create apps that meet the needs of patients and providers using established parameters while patients and providers will have

increased confidence in the use of mHealth apps (Xcertia, 2017). MHealth apps should be certified or recognized for meeting established standards in order to be recognized by patients and providers. In addition, it would be useful for a certifying body to provide a repository or forum for providers to share evaluations of mHealth apps. This will allow providers to share professional input on mHealth apps in the practice setting.

Limitations of the Study

This study provides background information useful for providers interested in mHealth apps as a clinical resource for patient information. It serves as baseline information for researchers interested in patient education or educational technology. Knowledge of perinatal mHealth apps and how they can be effectively used could assist app developers with the creation of mHealth apps for other health conditions. Findings from this study could assist in the process and policy development of mHealth app guidelines. While there are benefits, this study was limited in scope.

First, the evaluation of the perinatal mHealth app marketplace was conducted at a single point in time. The mHealth marketplace is constantly changing due to apps being created, updated, or removed without notice. Therefore, the assessment of available mHealth apps has limited generalizability. The mHealth apps selected for evaluation were those that were found to include most of the recommended health education topics for pregnant and postpartum women. There was selection bias in this process. Further evaluation should be conducted on mHealth geared towards single perinatal topics, such as

breastfeeding, and on apps that include fewer educational topics to better understand how well apps supply perinatal information. The perceptions of women who used apps during pregnancy and postpartum provided insight on unique characteristics of apps as a health information tool. However, the women who participated in this study were self-selected from a single geographic region. They may have been savvier with technology than the general populations and their perceptions may not be transferrable to others. Further research should be done to determine the perceptions of women on a wider scale.

Conclusion

This study underscores the need for the healthcare and app industries to work together towards using and creating apps that meet patients' educational needs in an accurate, accessible, and secure manner. Based on this study, women are using apps for perinatal information and they are accessing them frequently. Yet, based on interviews conducted in this study, most providers are not discussing them with patients. Because patients could conceivably receive a significant amount of information in an app format, providers should steer patients toward apps that have been vetted. App content should be developed based on accurate health information derived from healthcare professionals using established standards as guidelines. Understanding perinatal mHealth app availability and clinical use may help inform childbearing women. It may also assist with the development and use of mHealth apps serving other patient populations.

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Appendix A

mHealth Apps Initial Survey

App Name	Developer	Downloads	Average user rating	Located
Mayo Clinic on Pregnancy	Mayo Clinic	5k	4.0	iMedical apps review
Sprout pregnancy	MedArt Studios	100,000	4.4	iMedical apps review
iBirth	Lula B	5k	3.4	Google search
My Pregnancy A to Z	U.S. Air Force Medical Service	1,000	3.1	Imedical apps review
My Pregnancy and Baby Today	Baby Center	> 10,000,000	4.6	Google Play

Appendix B

Sample Interview guide

Understanding how Perinatal mHealth apps are Perceived by Pregnant or Postpartum Women

	Question	Elaboration Question
App Experience	Tell me about your experience using apps?	● In the past year, have you used an app to find health information? Why or why not?
mHealth App Experience in pregnancy	Tell me about your experience using apps to learn about your pregnancy or your baby?	● What apps did you use? ● How did you find them? ● How often did you use them? ● What concerns (if any) do you have about using apps for pregnancy information? ● What other sources did you use for pregnancy information? ● What did your friends or family say about using apps in pregnancy? ● Did your healthcare provider(s) talk to you about using apps in your pregnancy?
Usability	When you used apps for pregnancy information, what was it like for you?	● What did you think about using apps to find information? ● What features worked better for you? Why? ● What challenges did you have using apps? What did you do with an app you found challenging? ● What features did you want in an app that weren't available? ● Were there app features that were frustrating for you when you wanted information? What were they? Why were they frustrating? ● How many times did you typically use an app before you felt comfortable with how it worked? ● What did you do when you had an app you had difficulty using? ● Would you feel comfortable asking your healthcare provider for help using an app? Why or why not?

Usefulness	What topics did you feel mHealth apps seemed to cover the most? The least?	● What topics did you want to see in an app that you couldn't find? ● When you wanted more information on a topic than was available in app, what did you do? ● How often did that happen to you?
Desirability	What do you like about using apps for pregnancy information?	● Did you have a favorite app? (Which one?) ● What did you like about your favorite pregnancy related app? ● Are there features within a pregnancy related app that you find particularly useful? What about them do you like? (Videos, contraction times, kick counters, journals, physician question features, etc.)
Talk Aloud	Please select and open one of the apps on this smartphone. Please look through the app to find information about the signs of preterm labor and how to position a baby for breastfeeding.	● Please tell me what you are thinking as you open and use the app. ● What are signs of preterm labor? ● How would you position a baby for breastfeeding? ● What did you like and not like about this app?
Future Behavior	How do you see yourself using apps for health information in the future?	Would you recommend an app for pregnancy information to a pregnant friend or relative? Why or why not?
Thank you	Is there anything else you would like to add?	

Appendix C

Sample Demographic Information Form

For this research project, the researchers are requesting demographic information. Due to the make-up of Idaho's population, the combined answers to these questions may make an individual person identifiable. The researchers will make every effort to protect your confidentiality. However, if you are uncomfortable answering any of these questions, you may leave them blank.

Demographic Data

- How old are you? _____
- How would you describe your race/ethnicity? _____
- How much schooling have you had? _____
- Do you work? What is your occupation? _____
- Is English your first language? If no, what is your first language?

  _____

Pregnancy/ Information

- How far along are you in your pregnancy? _____
    - If applicable: When did you deliver your baby?

      _____
- What number baby is this for you? _____
- Approximately how many visits have you gone to?

  _____
    - If applicable: Did you go to your postpartum visit as scheduled?

      _____
- Do you typically see the same provider for each of your visits?

  _____

- Do you feel your provider did a good job answering your pregnancy/postpartum related questions? _____
- What types of resources did your provider give you during your office visits to help you learn about your pregnancy? _____
- Did you go to any childbirth education classes? (What type? E.g. Prenatal, breastfeeding, cesarean birth, newborn care, pain control techniques, etc.) _____
- Where do you go for more information about your pregnancy when you are not at a prenatal visit? _____

Technology Information

- How comfortable are you with using the internet? (0 = not comfortable, 10 = extremely comfortable) _____
- How do you typically access the Internet? _____
- Do you have access at your home? _____
- Do you have your own computer or do you share it with others? _____
- Do you have your own mobile device? What kind? Is it capable of downloading apps? What operating system does it use? _____
- In the past year, have you used the Internet to find health information? Why or why not? _____

Thank you very much for your time.

Appendix D

Sample Recruitment Flyer

Are you interested in participating in a research study?

Did you use an app for information about your pregnancy? If so, you are invited to participate in a research study about apps in pregnancy.

You are eligible if you:

- Used at least one app during your pregnancy
- Are over 18 years old
- You are pregnant or delivered within the past six months.

Participation involves an interview with the researcher that will take approximately one hour. Participants may be contacted by the researcher via phone or email after the interview to verify findings or to ask follow-up questions.

Participants will not receive direct benefit by participating in the study. Participants may decide to withdraw at any time. Participants will receive a $10 Target or Walmart gift card for their time.

This dissertation research is conducted by Kelley Connor, PhD Candidate at the University of Kansas School Of Nursing, under the supervision of Dr. Karen Wambach, Professor, University of Kansas School of Nursing. (IRB number: #187-SB17-086)

If you are interested, please email kelleyconnor@boisestate.edu or call 208-426-2641.

Appendix E

Sample Letter Requesting Flyer Distribution

Date

Dear [Mr. / Ms. LAST NAME],

I am a PhD candidate at the University of Kansas School of Nursing. I am conducting a qualitative research study for my dissertation on the use of mobile apps that provide education to pregnant or postpartum women. I am recruiting participants who are pregnant or are less than six months postpartum and used an app during pregnancy to meet with me for an individual interview about their experience. This study is important because it could provide insight on the use of apps as a patient education tool.

I am hoping you will post the enclosed flyer in an area visible to patients. My contact information is posted on the flyer for individuals interested in participating in the study.
This research is conducted under the direction of Kelley Connor, PhD student at the University of Kansas School of Nursing, under the supervision of Dr. Karen Wambach, Professor, University of Kansas School of Nursing. (IRB number: # 187-SB17-086)

Please don't hesitate to contact me if you have questions. Thank you for your time and consideration.

Sincerely,

Kelley Connor, PhD Candidate, University of Kansas School of Nursing
kelleyconnor@boisestate.edu
(208) 426-2641

Appendix F

Sample Snowball Recruitment Letter

Dear [Mr. / Ms. LAST NAME],

Thank you for your interest in the mobile apps in pregnancy study. I am writing to ask whether you would be willing to pass along the enclosed information to friends and/or family members who may also be interested in learning about this research study. You are under no obligation to share this information and whether or not you share this information will not affect your relationship with the staff at Boise State University.

Thank you for your time and consideration.

Sincerely,

Kelley Connor, PhD student, University of Kansas School of Nursing

Appendix G

Research Consent

Study Title: Evaluating Mobile Health Apps for Pregnancy
Principal Investigator: Kelley Connor, PhD Candidate, University of Kansas School of Nursing
Co-Investigator: Karen Wambach, PhD, RN, IBCLC Professor and Dissertation Advisor, University of Kansas School of Nursing
Sponsor: None

This consent form will give you the information you will need to understand why this research study is being done and why you are being invited to participate. It will also describe what you will need to do to participate as well as any known risks, inconveniences or discomforts that you may have while participating. We encourage you to ask questions at any time. If you decide to participate, you will be asked to sign this form and it will be a record of your agreement to participate. You will be given a copy of this form to keep.

➢ PURPOSE AND BACKGROUND

You are being asked to join a research study that evaluates mobile applications that could be used to educate women about pregnancy or the period after the baby is born. You are being asked to take part in this study because you are a woman (18 or older) who is pregnant or delivered an infant within the past six months. You do not have to participate in this research study. The main purpose of this research is to understand how women access information in a mobile health app and to find out more about what they would want from apps that provide health information and to help develop criteria to evaluate good apps. Research studies may or may not benefit the people who participate.

➢ PROCEDURES

If you agree to be in the study, you will be asked to participate in an interview with Kelley Connor. The interview will take approximately one hour. During the interview, you will be asked about your pregnancy, how you obtained pregnancy information, apps you used during your pregnancy, and what you thought of the apps you used during your pregnancy. The interview will be audio-recorded and the researcher may take notes as well.

After the interview takes place, the researcher may contact you by email or telephone to verify or clarify findings. You can choose to answer questions or not with no repercussions to you.

➢ RISKS

Some of the questions asked may make you uncomfortable or upset. You are always free to decline to answer any question or to stop your participation at any time. Should you feel discomfort after participating, you contact the

researcher and ask that your interview be removed from the study. There will be no problems for you if you decide to not answer a question, if you decide to end the interview, or if you ask to have your interview removed from the study.

➢ **BENEFITS**

There will be no direct benefit to you from participating in this study.

➢ **EXTENT OF CONFIDENTIALITY**

Reasonable efforts will be made to keep the personal information in your research record private and confidential. Any identifiable information obtained in connection with this study will remain confidential and will be disclosed only with your permission or as required by law. The members of the research team and the Boise State University Office of Research Compliance (ORC) may access the data. The ORC monitors research studies to protect the rights and welfare of research participants.

Your name or identifiable information will not be used in any written reports or publications which result from this research. Data will be kept for three years (per federal regulations) after the study is complete and then destroyed.

➢ **PAYMENT/COMPENSATION**

You will receive a $10 gift card to either Target, Walmart, or Starbucks at the completion of the interview.

➢ **PARTICIPATION IS VOLUNTARY**

You do not have to be in this study if you do not want to. If you volunteer to be in this study, you may withdraw from it at any time without consequences of any kind or loss of benefits to which you are otherwise entitled. Participation will not affect your care or services from your healthcare provider.

➢ **QUESTIONS**

If you have any questions or concerns about your participation in this study, you should first contact the principal investigator, Kelley Connor, PhD(c) at kelleyconnor@boisestate.edu or (208) 426-2641. You may also contact the co-investigator and dissertation research mentor, Dr. Karen Wambach, University of Kansas School of Nursing, at kwambach@kumc.edu or (913) 588-1639.

If you have questions about your rights as a research participant, you may contact the Boise State University Institutional Review Board (IRB), which is concerned with the protection of volunteers in research projects. You may reach the board office between 8:00 AM and 5:00 PM, Monday through Friday, by calling (208) 426-5401 or by writing: Institutional Review Board, Office of Research Compliance, Boise State University, 1910 University Dr., Boise, ID 83725-1138.

DOCUMENTATION OF CONSENT

I have read this form and decided that I will participate in the project described above. Its general purposes, the particulars of involvement and possible risks have been explained to my satisfaction. I understand I can withdraw at any time. I have received a copy of this form.

Printed Name of Study Participant	**Signature** of Study Participant	Date

Signature of Person Obtaining Consent	Date