Prenatal eHealth Tools for Expectant Parents: A Report to Inform Prenatal Education Efforts in Saskatchewan

A Report Prepared for the
Saskatchewan Prevention Institute
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Executive Summary

Expectant parents today have access to a wealth of information on pregnancy and child-birth and much of that information is accessed electronically. Knowledgeable healthcare providers who understand the strengths and limitations of these new technologies are in an excellent position to offer expert guidance to women using these technology-based prenatal health tools. Technology-based tools can provide cost-effective health services and information through the Internet and mobile devices to improve healthcare services and health outcomes. This technology can benefit consumers and healthcare providers, as well as those working in health education, promotion, research, and surveillance.

This report seeks to educate the Saskatchewan Prevention Institute and other interested stakeholders about eHealth, what it entails, the potential benefits and challenges, and recommended options for using eHealth to provide quality prenatal information to residents of Saskatchewan.

Research shows most Canadians to be highly technologically literate, generally well supported with the required infrastructure, and enthusiastic users of both Internet and mobile communications technologies. Saskatchewan has the second highest percentage of households in Canada with an active mobile phone, and smart-phones are becoming the preferred method of receiving personal health information electronically.

Technology-based health tools include *eHealth,* broadly defined as the use of information and communications technologies in support of healthcare consumers and those who work in health and health-related fields, and *mHealth*, a subset of eHealth that uses mobile technologies such as mobile phones, tablets, and personal digital assistants.

Researchers around the world are examining many different aspects of prenatal care in the context of mHealth technologies and many examples demonstrating positive health outcomes are found in literature. The use of mobile phone technologies for health promotion and disease prevention has advanced rapidly in recent years. Prenatal mHealth tools show great promise in positively influencing birth outcomes for both mother and child; however, until more conclusive research is generated and published, these tools should never be viewed as replacements for clinical prenatal care. Current prenatal mHealth tools can be an excellent option if viewed as additional sources of information or additional means of engagement.

Prenatal eHealth or mHealth may be particularly beneficial for specific populations that have limited access to prenatal health information. Considered in the report are populations within Saskatchewan that might particularly benefit from the use of eHealth tools, including young parents, lower socio-economic groups, and rural and remote families.

There is an abundance of prenatal eHealth and mHealth tools available for expectant parents; so many in fact, expectant parents and healthcare providers may feel overwhelmed in their search. Complicating matters, the informational quality of these tools ranges from excellent to poor, with some that could be

classified as harmful. Online health information and tools are not evaluated or regulated in Canada or elsewhere in the world. Access to online information and tools are generally very difficult to restrict, as electronically available health information is 'borderless'. Guidelines are highlighted that can be used to assess information credibility and accuracy.

Potential next steps to be explored by the Saskatchewan Prevention Institute and interested partners include: 1) creating a list of recommended eHealth and mHealth resources for healthcare providers to recommend to prenatal women; and/or 2) develop or adapt an eHealth or mHealth tool specifically for Saskatchewan.

Creating a list of recommended eHealth and mHealth resources would require a scan of the extensive number of tools already developed and currently available for public use. These tools are often made available to the public as-is, and cannot be modified aside from a few customer preferences. An evaluation and review by a Subject Matter Expert would be required to compile a list of trustworthy resources that healthcare providers could feel comfortable recommending to prenatal women. The second option is to develop a new or adapt an existing prenatal eHealth or mHealth tool locally. This would allow for the development of prenatal eHealth or mHealth tools that speak directly to the needs of Saskatchewan residents. This option would require a serious commitment of time, expertise, and financial resources to ensure success. A partnership with government, Health Regions, interested stakeholders, a local college or university, and interested corporations would help to ensure that the product met the needs within the province, was recognized as a reliable source of information, was cost effective, and had sufficient and sustainable funding.

1. Introduction

Expecting parents today have access to a wealth of information on pregnancy and child-birth, and much of that information is accessed electronically. Volumes of prenatal health information are simply a mouse-click away. While the emergence of these technologies is perceived by some health professionals as shifting the control of information from trusted sources to non-trusted sources, knowledgeable healthcare providers who understand the strengths and limitations of these new technologies are in an excellent position to offer expert guidance.

Health information accessed electronically is commonly referred to as *eHealth*. Not surprisingly, today's parents are frequent users of eHealth, primarily through Internet and mobile technology. Research has repeatedly shown that these parents want readily-accessible, short, concise, and quick answers to their pregnancy and child rearing concerns, with a trend towards a preference for information that is readily accessible on mobile devices (Bianco, Zucco, Nobile, Pileggi, & Pavia, 2013; Hearn, Miller, & Lester, 2014; Khoo, Bolt, Babl, Jury, & Goldman, 2008; Willis et al., 2015).

The Saskatchewan Prevention Institute understands the importance of expectant parents having access to high quality, current, evidence-based information on pregnancy and child birth, and recognizes that the Internet and mobile devices may be a way to facilitate pregnant women and their partners receiving this information when they need it. However, challenges or limitations to this method of sharing information do exist. This report was commissioned to educate the Prevention Institute and other interested stakeholders about eHealth, what it entails, the potential benefits and challenges, and recommended options for using eHealth to provide quality prenatal information to the residents of Saskatchewan.

The benefits of prenatal education are well established. Prenatal health information delivered through eHealth tools offers many additional benefits (Best Start, 2015; Nieuwboer, Fukkink, & Hermanns, 2013; Plantin & Daneback, 2009; Salonen et al., 2011). Many of the most commonly described benefits include:

- increased convenience, on-demand access, flexible scheduling, self-paced learning, limitless review, multi-lingual options, mobile viewing
- a reduction in the time commitment associated with traditional prenatal classes
- reduced costs; primarily transportation costs but sometimes expenses associated with prenatal group or individual classes
- providing access when local prenatal classes are fully enrolled
- providing options where the online option is the best choice based on personal preferences or scheduling conflicts
- providing options for parents with young children that may lack childcare, may lack affordable childcare, or prefer not to leave their children during the evening
- accessible prenatal information for a mother that may be on bed rest
- providing options that allow both parents to participate in prenatal education when dealing with busy schedules that make it difficult to attend classes together.

- providing options for parents that do not like crowded classes, or prefer an alternate environment (e.g., at home, small groups, or only with friends or family)
- an alternative when parents cannot find a class nearby that satisfies their needs, or they seek prenatal information not typically available in their community
- offering prenatal health information sourced from a wide variety of health, governmental, and non-governmental agencies, and from multiple sources world-wide
- the potential for development of a virtual (online) peer and professional parenting support network that may be based on unique interests, and is not limited by location or geographic boundaries

Beyond traditional sources of prenatal health information and services, prenatal eHealth tools, if developed by Subject Matter Experts, can offer additional and complementary options for the delivery of current, accurate, and reliable health information in ways that reflect the changing role of technology in our society. To best take advantage of this rapidly changing reality, Saskatchewan, like all provinces, will require a multifaceted and innovative eHealth strategy that includes "new, culturally congruent health information, social marketing messaging, and modern communication strategies – all designed to support the highest levels of healthcare quality" (Canada Health Infoway, 2015, p.2).

There are also challenges associated with using technology-based tools to access prenatal health information which include inconsistent Internet access for some populations, and an abundance of existing electronically available prenatal information that lacks regulation and evaluation. For these reasons, prior to promoting technology-based prenatal tools, it is important to be well-informed of the evidence, current status of provincial Internet and mobile phone use, and knowledge of local initiatives that provide Saskatchewan-based prenatal information electronically. This project demonstrates the Saskatchewan Prevention Institute's commitment to providing equitable access to high quality, up-to-date and evidence-based information for healthcare providers and the public.

1.1 Goals of Review

The purposes of this report are:

i. To produce a current evidence-based summary of the research on eHealth tools that provide prenatal health information to pregnant women and parents to be, with an emphasis on content specific to use in Saskatchewan.
ii. To provide a background understanding of the evolution of electronic information technology in the Canadian and Saskatchewan context in order to frame the discussion of eHealth in Saskatchewan moving forward.
iii. To conduct a literature review to summarize current evidence regarding the use of eHealth tools. This evidence includes research from peer-reviewed health and information technology literature, government reports, sponsored and independent reports, professional guidelines, as well as informal sources and grey literature.

iv. To conduct an environmental scan to identify prenatal eHealth resources used in Saskatchewan and explore examples of technology-rich eHealth tools that have been successfully implemented in other provincial, national, and international jurisdictions, and are assessed as logistically and financially feasible to implement in Saskatchewan.
v. To summarize the laws and regulations that have been established in order to protect the public by ensuring the quality and safety of prenatal eHealth tools.
vi. To summarize the best strategies and methods of delivery for providing prenatal information to parents-to-be and caregivers when using appropriate technology-based eHealth tools.
vii. To provide information that could lead to the provision of a current evidence-based referral resource on prenatal eHealth tools for health information resource providers and professionals in Saskatchewan.

1.2 Scope of Report

The scope of this report will include:

i. A preliminary assessment of prenatal eHealth tools judged as having a *significant* technology (computer-based) component (e.g., online resources, online tutorials, mobile phones, telehealth services) and were identified as potentially being relevant to the needs of Saskatchewan expectant parents.
ii. A review of successful eHealth tools evaluated as effective in improving prenatal and post-childbirth health outcomes for the mother and/or child.
iii. Options for the development of prenatal eHealth tools specific to the needs of expectant parents in Saskatchewan, using local resources and developed using a collaborative approach among stakeholders.
iv. A review of eHealth tools determined to be logistically and financially feasible (broadly defined) for recommendation and implementation in Saskatchewan.

1.3 Audience

This review is intended for Saskatchewan Prevention Institute staff and other interested stakeholders. This information may be shared with healthcare professionals, healthcare service providers, educators, and researchers providing prenatal services throughout Saskatchewan.

1.4 Terminology

The fields of Medicine and Computer Science are well known for their unique vocabularies and terminologies. Several common terms are defined below for the purpose of this review, and for readers who may be interested in further independent research.

What exactly is *eHealth* and *mHealth*? Many definitions exist, but well referenced and broadly-defined examples come from the World Health Organization; “eHealth is the cost-effective and secure use of information and communications technologies in support of healthcare providers, healthcare consumers, health and health-related fields including healthcare services, health surveillance, health literature, and health education, knowledge and research.” (World Health

Organization [WHO], 2015, p.1). The WHO defines mHealth as "…an area of electronic health (eHealth), and it is the provision of health services and information via mobile technologies such as mobile phones and Personal Digital Assistants (PDAs), to improve health outcomes, healthcare services and health research…" (WHO, 2012, p.1).

It is important to note that the terms 'eHealth Tools' and 'Health eTools' are often used interchangeably in the literature, but have the same meaning. In Canada, the term 'eHealth Tools' is more frequently used.

Health Informatics is a discipline at the intersection of healthcare delivery, computer science, and information technology. More precisely, Health Informatics is the knowledge, skills, and tools which enable information to be collected, managed, used, and shared to support the delivery of healthcare and to promote health (Dalhousie University, 2015). Health Informatics is broadly defined, and includes many sub-specialties (e.g., medical informatics, healthcare informatics, clinical informatics, pathology informatics, nursing informatics, bioinformatics, pharmacy informatics, public health informatics, community health informatics, home health informatics, dental care informatics, and consumer and personal health informatics).

Prenatal eHealth tools could certainly be classified under several of the categories mentioned, but they are generally thought to fall under the umbrella of 'Consumer and Personal Health Informatics'. These tools include resources accessed online or off, and from desktop, laptop, or mobile devices.

Consumer and Personal Health Informatics is the study of, and development of, solutions which help individuals better follow their health and wellness status, detect and predict changes, and identify and implement concrete lifestyle changes towards a healthier and happier life. Research and development is done in close collaboration with healthcare professionals, behavioural scientists, and information technology companies. People working in Consumer and Personal Health Informatics strive to help in the prevention and management of a variety of health-related concerns. Research areas include mobile health, health monitoring technologies, education, data analysis and interpretation, decision support systems, user interface design, and software engineering (Northeastern University, 2015).

The rapid integration of mobile devices into clinical practice and daily life has been, in part, driven by the rising availability and quality of medical software applications called *apps*. 'App', short for 'application program', refers to a self-contained piece of software coded for a specific purpose and usually optimized to run on a mobile device, as opposed to a desktop or laptop computer (Ozdalga, Ozdalga, & Ahuja, 2012). The ability to download health and medical apps on mobile devices has made a wealth of mobile clinical resources available to healthcare professionals and the public. Faster processors, improved memory, smaller batteries, and highly efficient open-source operating systems that perform complex functions have paved the way for

the development of a flood of medical mobile device apps for both professional and personal use (Mosa, Yoo, & Sheets, 2012).

An *electronic book* (aka: e-book, eBook, e-Book, ebook, digital book, or e-edition) is a book composed in or converted to digital format for display on a computer screen or handheld device (Merriam-Webster, 2016). These digital books may consist of any combination of text, images, videos, interactive programs, and are readable on computers or other electronic devices. Although sometimes defined as an electronic version of a printed book, many e-books exist without any printed equivalent. Any sophisticated electronic device that features a controllable viewing screen, including computers, tablets and smartphones, can also be used to read e-books. The e-book may be considered both an application of eHealth and mHealth. Electronic books offer several advantages: a huge number of e-books can be stored in portable units, dramatically eliminating weight and volume compared to paper; electronic bookmarks make referencing easier; and electronic devices often allow the user to annotate pages. Additionally, technical material is especially suited for e-book delivery because it can be searched (PC Magazine, 2016).

The *smartphone* is a cell-phone and handheld computer that many feel has created the greatest tech revolution since the Internet. A smartphone can do everything a personal computer can do and because of its mobility, much more. Although screen size is a limitation, the increasingly higher resolutions make viewing pleasurable, and voice recognition can eliminate a fair amount of typing. A smartphone combines a cell-phone with e-mail and Internet, music and movie player, camera and camcorder, GPS navigation, voice dictation for messaging, and a voice search for asking questions. Like any computer, what gives life to the hardware is the software, the applications, and there are hundreds of thousands of mobile applications available (PC Magazine, 2015).

Health Information Seeking represents "…intentional, active efforts to obtain specific information above and beyond the normal patterns of media exposure and use of interpersonal sources. It includes any non-routine media use, or interpersonal conversation about a specific health topic and thus includes behaviors such as viewing a special program about a health-related treatment, using a search engine to find information about a particular health topic on the Internet, outside normal conversation" (National Library of Medicine, 2011).

1.5 Methodology

1.5.1 Literature Review

A literature review is an account of what has been published on a topic by accredited scholars and researchers. In writing a literature review, the purpose is to convey to the reader what knowledge and ideas have been established on a topic, and what their strengths and weaknesses are (University of Toronto, 2016).

A systematic search of public and academic databases (e.g., Google, Google Scholar, Bing, Microsoft Academic, CINAHL, and PubMed) was completed in 2015. Given the goal of producing a report based on current evidence, the search was restricted to research extending back five years, to 2010. The evidence included research from peer-reviewed health and information technology literature, government reports, sponsored and independent reports, professional guidelines, as well as informal sources and grey literature. Qualitative and quantitative research was included. All databases were systematically searched using the following search terms (not an exhaustive list): prenatal, pre-natal, pre-delivery, pre delivery, classes, effectiveness, pregnant, pregnancy, mom, mother, parent, information, technology, IT, computer, tablet, app, apps, mobile, phone, smartphone, smart-phone, smart phone, device, health, informatics, eHealth, and mHealth. These terms were used individually and in combination.

1.5.2 Environmental Scan

Environmental scans originated in a business context as a tool for retrieving and organizing data for decision making. Environmental scans have been mainly used to investigate external factors that are interpreted as keys to success, and affect the future of an organization. These scans are used to provide decision makers with knowledge about current social, economic, technological, and political contexts, and to identify any potential short and long-term shifts (Graham, Evitts, & Thomas-MacLean, 2008).

An important goal of environmental scans is information aiding the design of health programs that are geared toward, and incorporate the needs of specific communities. In all domains, environmental scans are designed to help plan for the future, to raise awareness of issues, or to initiate a project. Environmental scans can also assist health organizations with the development of evidence-based policies (Graham, Evitts, & Thomas-MacLean, 2008).

The environmental scan conducted for this review combined an Internet search with email and phone contact with relevant organizations and individuals. Included in the environmental scan is information on the existing eHealth resources that may be relevant to the purposes of this report, background information on populations of special interest relevant to this review, an assessment of the telecommunications infrastructure in Canada and Saskatchewan required to facilitate eHealth adoption, and information on the proper assessment of eHealth and mHealth content.

1.6 Conflict of Interest

The author has no affiliations with, or involvement in, any organization or entity with any financial interests (such as, but not limited to, honoraria, educational grants, participation in speakers' bureaus, membership, employment, consultancies, stock ownership, other equity interest, expert testimony, or patent-licensing arrangements), or non-financial interests (such as, but not limited to, personal or professional relationships, affiliations, knowledge, or beliefs) in the subject matter or materials discussed in this report.

2. Literature Review on Effectiveness of eHealth and mHealth Tools

The vast majority of prenatal eHealth and mHealth tools have yet to be rigorously studied or comprehensively evaluated. This is likely a reflection of their relatively recent arrival on the healthcare scene, limited research resources, as well as the large and rapidly increasing number of prenatal tools available. This is not to say these tools offer no value in improving health outcomes for mother and child, or that these tools must not be used until they are 'proven' effective – their use, however, should be approached with some caution. The lack of comprehensive evaluation of these tools creates a great opportunity for future research and publication.

This is an exciting time to be investigating the possible health benefits of eHealth and mHealth interventions for prenatal care. Literature supporting the efficacy of eHealth and mHealth tools for prenatal care is evolving rapidly. At this stage, published research generally consists of discussion papers, proof-of-concept proposals, pilot studies, small-scale evaluations, opinion pieces, and grey literature. Very few qualitative or quantitative publications are seen in well-respected, peer-reviewed journals; but of those available, several will be discussed in more detail in the following sections. While there are reports indicating small to moderate positive benefits, (e.g., fewer missed prenatal examinations, improved knowledge of prenatal nutrition, improved understanding, and compliance with prenatal supplements), the evidence is not fully convincing, primarily because of the limited number of studies available and methodological limitations. Regardless, experts in prenatal eHealth see tremendous potential for improving birth and health outcomes (Tamrat & Kachnowski, 2012).

2.1 Prenatal Online eHealth Resources

Most prenatal health information found online is simply an electronic adaptation of the same information that was previously found in traditional printed sources. Of course, additional features such as videos and interactive exercises may be added, but the primary content remains the same. This could explain why recent published research comparing the quality of online and traditional sources of prenatal health information could not be found. Somewhat surprisingly, there was also no published research found comparing the two approaches on prenatal health outcomes.

It is important to recognize that at this time, because of limited research, it cannot be stated confidently that providing prenatal health information exclusively online, effectively influences health behaviour or outcomes in a positive way.

Prenatal health information, like all health information found online, is always subject to rapid change and evolution, meaning that information on a given website may be out-of-date soon after it is published (Eysenbach, Powell, Kuss, & Sa, 2002). Because of the vast number of online resources available to parents, the best advice when recommending prenatal eHealth information found online is to follow the recommendations outlined in section 3.3.2.

2.2 Prenatal mHealth Research Areas

Researchers around the world are examining many different aspects of prenatal care in the context of mHealth technologies, and many examples demonstrating positive health outcomes are found in the literature. For example, several prenatal mHealth applications specific to midwifery care have been shown to improve birth outcomes for both the infant and mother (Robinson & Jones, 2014; Speciale & Freytsis, 2013; Tamrat & Kachnowski, 2012; Tripp et al., 2014). The outcomes measured included improvements that facilitated emergency medical responses, better point-of-care support, health promotion activities, and data collection used in program development.

Additionally, there are a growing number of published research papers on the positive application of prenatal mHealth tools in rural and developing areas of the world (DeStigter, 2012; McCartney, 2012; Nurmatov et al., 2014; Tsinghua University, 2014). For example, a study conducted in Zanzibar concluded that the “wired mothers” mobile phone intervention significantly increased the proportion of women who received the recommended four prenatal care visits. In addition, there was a trend towards better quality of care during pregnancy, with more women receiving preventive care, care late in pregnancy, and more women with late pregnancy complications being identified and referred. It was suggested that mobile apps may contribute to improved maternal and infant health (Lund et al., 2014).

Exciting research has been published in the area of prenatal lifestyle and behavioural change using mHealth applications. Various studies have reported positive, and sometimes significant health outcomes, including better reported nutrition (increased fruit and vegetable consumption), increased involvement in physical activity, smoking cessation (Abroms et al., 2012), improved stress management, and more appropriate weight gain during pregnancy (Hearn, Miller, & Lester, 2014; Kennelly et al., 2015; Malakouti, Sehhati, Mirghafourvand, & Nahangi, 2015; Mauriello, Van Marter, Umanzor, Castle, & de Aguiar, 2015; Willcox et al., 2015).

These examples represent only a small number of research areas within the context of prenatal mHealth currently explored around the world. While much of the research is exploratory at this time, and a great deal more needs to be done, it is clear from the literature that investigators

are excited and encouraged by the positive improvements in health outcomes seen in both mother and child when adopting mHealth tools.

2.3 Prenatal mHealth Text-Messaging Services

A potentially powerful application of mHealth in prenatal education, health promotion, and positive health outcomes is text messaging. *Short Message Service* (SMS) is the most common text messaging service component of phone, Internet, or mobile communication systems used today. Messages are typically up to 160 characters in length, and while SMS is most commonly used for text messaging between friends or co-workers, it can be used for healthcare purposes as well. For example, physicians can receive SMS messages regarding patient emergencies. One benefit is that text messages sent via SMS do not require the recipient's phone to be turned on in order for the message to be successfully transmitted. The SMS service will hold the message until the recipient turns on his or her phone, at which point the message will be sent to the recipient's phone. Most cell-phone providers allow a user to send and receive a certain number of text messages every month for no charge (TechTerms, 2015).

Research has shown text messaging to be beneficial in many areas of healthcare, and several well-conducted systematic reviews have been completed, though not exclusive to prenatal care. A recent systematic review by Yeager and Menachemi (2011) examined 61 well-designed studies; 82% found text messaging had a positive effect on the primary health outcome investigated. A systematic review conducted by Bert, Giacometti, Gualano, and Siliquini (2014) found positive evidence that text messaging may be helpful in health promotion activities. Cole-Lewis and Kershaw (2010), from the Yale University School of Epidemiology and Public Health, conducted a systematic review and provided an overview of behaviour change interventions for disease management and prevention delivered through text messaging. They found mobile phone text messaging to be a potentially powerful tool for behaviour change because it is widely available, inexpensive, and instant. Lastly, in a systematic review published by Déglise, Suggs, and Odermatt (2012), they found evidence that mobile phones are an appropriate and promising tool for disease control interventions in developing countries.

There is also research and evidence supporting the use of text messaging in prenatal care. Researchers in Argentina found pregnant women to be interested in text messaging services (Cormick, 2012). A recent systematic review published by Poorman and Gazmararian (2015) evaluated studies where text messaging was applied to the promotion of maternal and infant health. They found that interventions varied greatly in effectiveness and soundness of methodology, but collectively indicated that there is a wide range of preventative behaviours that text message interventions can effectively promote. These behaviours include smoking cessation, better diabetes control, and increased partner involvement. They also found improvements in the following – appointment attendance, medication adherence, weight management, nutrition, stress management, and vaccination uptake. The authors conclude that “Building on the growing body of evidence for text message interventions reviewed, as well as

the growing popularity of text messaging as a medium, researchers should be able to use this technology to engage difficult to reach populations" (Poorman & Gazmararian, 2015, p.969).

In addition to Poorman and Gazmararian (2015), other researchers have observed positive outcomes associated with reduced tobacco use when delivering tailored smoking cessation support to pregnant smokers via text messaging (Abroms, 2015; Inamdar, Croucher, Chokhandre, Mashyakhy, & Marinho, 2014; Kuang-Yi, 2014; Naughton, Prevost, Gilbert, & Sutton, 2012; Pollak, 2013).

Two interesting applications of mHealth, Text4baby and Yukon Baby, are particularly relevant within the context of this review, and will be discussed in greater detail in sections 2.3.1, 2.3.2 and 3.6.2.

2.3.1 Text4baby

Text4baby is a free text messaging program, based solely in the United States, for pregnant women and new mothers of infants aged one and younger. Text4baby was originally designed to improve maternal and child health (MCH) within underserved populations in the United States (there are no access restrictions currently in place). It is the first free national health text messaging service, made possible through an arrangement between the U.S. federal government, corporate sponsors, private donors, and most U.S. mobile providers. Text4baby provides evidence-based, critical health and safety information to mothers in the form of texts (Text4baby, 2015). The Text4baby program was implemented using a public-private partnership model to develop the message content and conduct outreach. Johnson & Johnson is the founding sponsor, providing direct financial and in-kind support to operate the program. The U.S. Department of Health and Human Services (DHHS) is the lead federal government partner, assisting with outreach, developing and approving message content, and providing evaluation support for the program (Whittaker et al., 2012).

Text4baby is the largest health text messaging program in the United States in terms of the number of subscribers and messages sent. Since the program's launch in February 2010, more than 830,000 mothers have signed up. After signing up, mothers receive a "starter pack" of six messages that provide critical health information and encouragement to connect to care. Using the due date or birth date, the system places subscribers in a messaging protocol to receive three text messages per week timed to the stage of pregnancy or age of the infant. Subscribers can opt out of Text4baby at any time by responding "STOP", at which point they will no longer receive messages or alerts. Text4baby does not collect health information on its user population and has instituted a privacy policy to protect user data at registration. In addition, Text4baby does not include advertisements in message content (Whittaker et al., 2012).

The U.S. Health Resources and Services Administration (HRSA) conducted a recent evaluation of the Text4baby program. Overall, there is strong support for the Text4baby public-private partnership. Stakeholders universally agreed that the partnership facilitated a faster implementation timeline than would have been possible under sole public or private sponsorship. Private sector stakeholders also noted that federal government involvement lent credibility to the program (U.S. Department of Health and Human Services [DHHS], 2015). The DHHS evaluation examined the type of health information received, level of health knowledge, selected preventive health behaviours, and referrals to health resources (DHHS, 2015). These evaluation measures were chosen based on the goals of the Text4baby program, which are to help women have healthy pregnancies and healthy babies by sharing high-priority health information, increasing their health knowledge, promoting healthy behaviours, and improving access through referrals to health resources.

The Text4baby evaluation used a mixed-method approach with two components reviewing the success of the program. The first component of the evaluation was to assess the implementation and evolution of the national roll-out of Text4baby. The second component was to evaluate the experiences of diverse communities in terms of participation, satisfaction, use, and local level effects. Four Community Health Centers (CHCs) were selected to assess the implementation of Text4baby. A data-driven approach guided selection of the four CHCs; however, it is important to note that the findings are not generalizable to all CHCs, all communities with CHCs, or all populations served by CHCs. Moreover, in the absence of a control group or external comparison group, the evaluation cannot attribute differences between and among groups to the impact of Text4baby, although significant differences may suggest associations with Text4baby participation status (DHHS, 2015).

Evaluation results were as follows:

- As of September 30, 2013, 79% of Text4baby subscribers initially registered for the pregnancy protocol, signing up before their due date, and 21% registered for the new baby protocol, signing up after their baby's birth date. About one-third of all subscribers signed up during the first trimester of pregnancy. Early research suggested that approximately 40% of Text4baby subscribers resided in a medically underserved area (DHHS, 2015).

- Text4baby awareness and participation rates varied across the CHCs recruited for the evaluation. Data is not available on the national level of Text4baby participation in CHCs. Therefore, the generalizability of the Text4baby enrollment experience in the four CHCs is unclear. Awareness rates, or the percentage of CHC prenatal care patients that indicated they had heard about Text4baby, ranged from 8 to 38% across

the four CHCs. Participation rates, or the percentage of CHC prenatal care patients that reported they signed up for Text4baby, ranged from 2 to 16% across the CHCs. The participation rate was substantially higher in the CHCs with strong provider support, with Text4baby posters displayed in clinic waiting rooms, and with direct involvement of a statewide MCH coalition in supporting community activities. This model of multilevel promotion and outreach holds promise for expanding the reach of Text4baby in the future (DHHS, 2015).

- The estimated rate of national Text4baby sign-up was 4.8% in 2012. The 2012 national participation rate is a ratio of the number of Text4baby subscribers with a due date or birth date in 2012 (numerator) to the total number of live births in the United States in 2012 (denominator). A similar method was used to calculate participation rates for 2010 and 2011. This method may overstate the national Text4baby participation rate among those delivering in a given year, because the numerator includes an unknown number of subscribers who were family members, providers, or observers. In addition, approximately 20% of subscribers unenrolled within 30 days, suggesting a minimal level of participation in Text4baby (DHHS, 2015). Miscarriages could account for some of this result.

- Text4baby enrollment nationally was lower than expected: in November 2010, the program set a goal to enroll "1 Million Moms" by the end of December 2012. The cumulative enrollment at the end of December 2012 was 480,000. The data show that a sizable proportion of CHC prenatal care patients who heard of Text4baby decided not to sign up. The majority of women who heard of Text4baby, but did not sign up, said that they had other sources of health information; a sizable proportion (one-third) said they were not comfortable with text messaging. The analysis has implications for refining the way Text4baby is marketed to women who may have other sources of health information during pregnancy. The findings suggest that Text4baby could be promoted as a complement to other sources of information, encouraging women to integrate its use with information from healthcare providers, family members and friends, and other media, such as books and Internet sources (Whittaker et al., 2012).

- Women who heard of Text4baby (regardless of whether they signed up) were significantly more likely to report receiving health information on 14 high-priority topics compared to women who never heard of Text4baby. In particular, women who had heard of Text4baby were significantly more likely to report they received information about exercising (93% vs 84 %), avoiding stress (90% vs 77%), receiving the flu shot (88% vs 76%), seeing a dentist (83% vs 74%), and calling a help line if they were depressed (81% vs 65%). When asked about their unmet needs for health information, women who never heard of Text4baby frequently mentioned critical

topics included in the Text4baby message protocol, such as information about Medicaid; the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC); breastfeeding and nutrition; and mental health issues. There were *no significant differences* in the receipt of health information between women who signed up for Text4baby and those who heard of Text4baby but decided not to sign up.

- The evaluation assessed women's (who were Text4baby subscribers) knowledge of four pregnancy/infant care topics: 1) how they plan to feed their babies, 2) what position they plan to lay their babies down to sleep in, 3) what they consider to be the best time to deliver when there are no medical problems in the pregnancy, and 4) when they view a pregnancy to be full-term. All of these health knowledge topics are also covered by large public health campaigns to promote evidence-based practices related to infant feeding, safe sleeping, and optimal delivery time. Among the CHC prenatal care patients, 90% reported that they plan to breastfeed their baby, 57% indicated that they plan to lay their baby down to sleep on his or her back, 69% responded that the best time to deliver when there are no medical problems is 39 to 40 weeks, and 60% were aware that pregnancy is considered to be full-term at 39 to 40 weeks. Eighty-one percent of women who signed up for Text4baby responded "correctly" to at least three of the four knowledge items, versus 60% to 62% of other CHC prenatal care patients who did not sign up for Text4Baby (DHHS, 2015).

- The DHHS evaluation assessed four preventive health behaviours of women who were text4baby subscribers: 1) receiving the flu shot in the past year, 2) daily prenatal vitamin use, 3) preventive dental visit in the past year, and 4) regular seatbelt use. These behaviours are associated with positive health outcomes during pregnancy and beyond. More than three quarters of CHC prenatal care patients reported they always used a seatbelt in the car (86%) or took a prenatal vitamin daily (82%). Only about half had a flu shot (55%) or a preventive dental visit (51%) in the past year. The percentage for each of these preventive health behaviours differed significantly according to whether women indicated they had received health information on the topic from any source. For example, 67% of women who received information on getting a flu shot reported they had a flu shot in the past year versus only 13% of those who did not receive such information. However, these differences are not directly attributable to participation in the Text4baby program (DHHS, 2015).

- A recent enhancement to the Text4baby service is the provision of telephone numbers that subscribers can call for more information about a specific topic. Most women who signed up for Text4baby (86%) said they signed up to receive telephone numbers for more information (among other reasons for subscribing). Few Text4baby subscribers (6%) indicated they had ever called a telephone number included in a

message. However, more than half (53%) indicated they had saved a telephone number to use in the future if they needed more information. The telephone numbers direct subscribers to helplines that are tied to the content of Text4baby messages, such as safe sleep, health insurance coverage, smoking cessation, breastfeeding, and substance abuse treatment. The majority of the helplines are sponsored by the U.S. federal government (DHHS, 2015).

In summary, although the participation rate was lower than expected, women who signed up for Text4baby valued the program; 99% of the Text4baby subscribers who received prenatal care from the four CHCs indicated they would recommend Text4baby to a friend or family member. The lessons learned are being applied to improve program operations, enhance the Text4baby product, and refine the outreach strategy in order to expand the program's coverage. Compared to CHC prenatal care patients who never heard of Text4baby, subscribers were significantly more likely to receive health information on high-priority topics during pregnancy. The data suggest that women who never heard of Text4baby are hard to reach with health information in general. In addition, as measured by their composite responses to four questions regarding knowledge of recommended health practices, women who signed up for Text4baby exhibited a significantly higher level of health knowledge than the other two groups of prenatal care users (women who had never heard of Text4baby and women who had heard of Text4baby but did not sign up). Text4baby's emphasis on delivering evidence-based health information via short, easy-to-understand messages may have contributed to the higher level of health knowledge among subscribers (DHHS, 2015). The findings suggest that integration of Text4baby with the delivery of prenatal services in existing health programs offers the potential to expand access to health information during pregnancy and improve knowledge about significant public health topics.

There are numerous articles examining the effectiveness of Text4baby in peer-reviewed journals. One study of pregnant female army soldiers found a significant reduction in alcohol consumption when exposed to a high number of Text4baby messages as measured by the question "Since you found out about your pregnancy, have you consumed alcoholic beverages?" (Evans et al., 2015).

Adequate health literacy is vital for understanding and utilizing health information. In one study, researchers assessed the health literacy of pregnant women and mothers of children under the age of 1 year, and their success in self-enrolling in the Text4Baby health message program. Results suggested a positive association between health literacy skills and successful self-enrollment in the Text4Baby program. *This suggests the need for additional outreach efforts to ensure enrollment of women with low health literacy skills* (Gazmararian, Yang, Elon, Graham, & Parker, 2012).

2.4 Summary

A note of caution is appropriate at this point in the review. In some ways, mobile technology has an almost *magical* appeal for many interested in public health, over and above the advantages that have been proven with sound policy and good clinical evidence. Part of this magical promise is that mobile technologies could potentially solve one of the most difficult problems facing public health efforts – the structural barriers to *access* (Tomlinson, Rotheram-Borus, Swartz, & Tsai, 2013). The potential certainly exists; however, improving access to healthcare is only one important element of a successful mHealth strategy.

The use of mobile phone technologies for health promotion and disease prevention has advanced rapidly in recent years. Prenatal mHealth tools show great promise in positively influencing birth outcomes for both mother and child. However, until more conclusive research is generated and published, these tools should never be viewed as replacements for clinical prenatal care. Current prenatal mHealth tools can be an excellent option if viewed as additional sources of information or additional means of engagement.

3. Environmental Scan

There are an abundance of prenatal eHealth and mHealth tools available for expectant parents; so many in fact, expectant parents and healthcare providers may feel overwhelmed in their search. Further, the informational quality of these tools range from excellent to poor, with some that could be classified as harmful. The environmental scan will provide examples of prenatal eHealth and mHealth tools ready for use today, as well as options for the future development of specific tools designed to meet the specific needs of prenatal health information provision in Saskatchewan. The advantages and disadvantages of each approach will be discussed in detail.

All prenatal eHealth and mHealth tools discussed in this review have been carefully considered using the criteria identified in figures 5 (section 3.3.2) and 6 (section 3.3.3) of this review. Any prenatal eHealth or mHealth tool failing to meet the appropriate criteria is not included. Given practical constraints, prenatal eHealth and mHealth tools that do not fit the criteria will not be referenced in this text.

It is important to note that the evaluation of any prenatal eHealth or mHealth tools are based on information available at the time of publication, and regular review is recommended. *In addition, the assessment was made based on indicators of the quality and credibility of the source of information, not on the actual accuracy of the information included, or on the functionality of the tool. These are additional aspects that would need to be assessed before a particular tool could be recommended.*

3.1 Populations of Special Interest

It is important to have an understanding of the typical users of an eHealth tool before an evaluation or recommendation can be made. Typical primary users of prenatal eHealth tools include pregnant women, their partners, family, and friends. Secondary users include healthcare professionals, informal caregivers, educators, and researchers.

There are several groups which deserve special attention within the context of this review, and may require unique strategies to allow for access to the prenatal eHealth tools recommended (Canadian Policy Research Networks, 2006). The Canadian Policy Research Networks have highlighted the importance of focusing on vulnerable populations that experience:

i. reduced access to healthcare services
ii. previous negative experiences with the healthcare system
iii. reduced access to Internet and mobile communications services
iv. language and communication barriers
v. unique cultural beliefs and practices
vi. lower educational attainment
vii. limited financial resources

Groups that may experience any or several of these obstacles in Saskatchewan include young parents, individuals living in rural or remote locations, newly arrived immigrants or refugees, and Aboriginal peoples (Canadian Medical Association, 2013; National Collaborating Centre for Aboriginal Health, 2011). These groups will be discussed in more detail below.

3.1.1 Young Parents

In Saskatchewan, pregnancy rates among young women are some of the highest in Canada and the developed world (Saskatchewan Prevention Institute, 2014). The range of age-specific fertility rates by Canadian provinces is outlined below in Table 1.

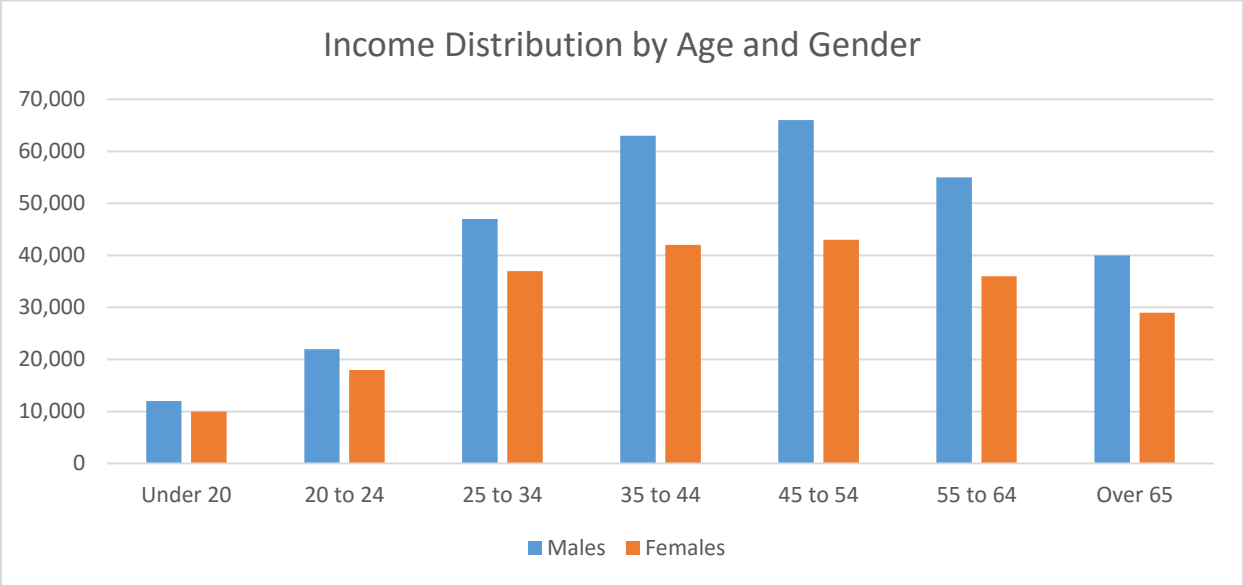
Table 1: Pregnancy Rates, Young Women, 2011 (Statistics Canada, 2013)

Province	Fertility Rate per 1,000 Females, < 19 Years	Fertility Rate per 1,000 Females, 20-24 Years	Fertility Rate per 1,000 Females, 25-29 Years
Newfoundland & Labrador	17.7	51.8	89.4
Prince Edward Island	16.6	49.0	104.8
Nova Scotia	17.3	51.2	86.2
New Brunswick	21.3	64.6	101.2
Quebec	9.2	48.6	111.8
Ontario	9.8	37.1	84.2
Manitoba	28.9	71.1	110.9
Saskatchewan	32.5	76.6	129.9
Alberta	17.3	58.9	107.8
British Columbia	8.5	34.2	76.8
Yukon	16.2	51.9	97.1
Northwest Territories	33.5	92.1	93.0
Nunavut	108.0	193.9	142.1
Canada	12.6	45.7	95.2

Many young parents face significant financial constraints, no matter where they live in Canada. While the average incomes and net worth of individuals in Saskatchewan is high

relative to many other provinces and territories (MoneySense, 2015), not surprisingly, as in the rest of Canada the distribution of wealth favours males, couples, and older adults (Figure 1). Appropriate recommendations will be based on this reality.

Figure 1: Income Distribution by Age and Gender, 2013 (MoneySense, 2015)



According to the Canadian Maternity Experiences Survey, mothers who are young, have lower educational levels, or are living in a household at or below the low income cut-off are classified as 'vulnerable populations'. Compared with other women, these mothers frequently reported less favourable maternity experiences, such as abuse, stress during pregnancy, and symptoms suggestive of postpartum depression. *Women in these groups are also more likely to report not having enough information about maternity-related topics*. The authors of the survey recommend young mothers and mothers with low socio-economic status be given particular attention when developing maternal health policies and programs (Public Health Agency of Canada, 2009). Prenatal eHealth tools offer an important option for parents in this group.

3.1.2 Rural and Remote Populations

In Saskatchewan, 67% of the population lives in an urban setting, while 33% lives in a rural location. This compares to 81% and 19% respectively in Canada (Statistics Canada, 2011). While not the largest percentage relative to several of the other provinces and territories, 33% is significant in terms of this review because living in a rural setting may limit an individual's access to healthcare services, as well as Internet and mobile phone connectivity.

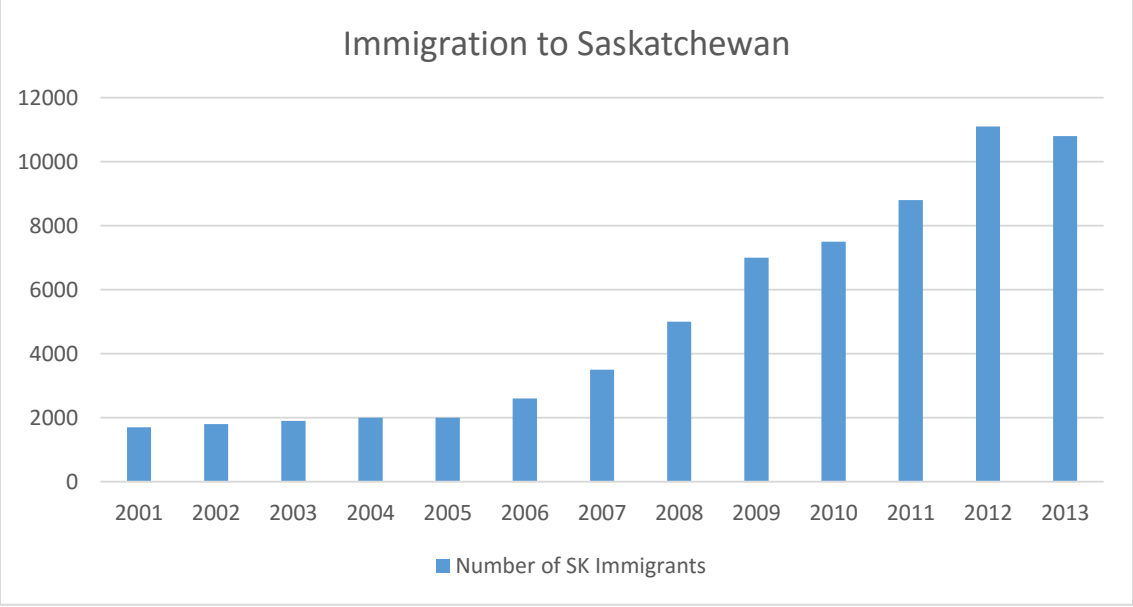
3.1.3 Immigrant and Refugee Populations

In 2013, 169 Saskatchewan communities saw the arrival of immigrants who migrated from 217 different countries. Saskatchewan reached an all-time population high in 2012, and immigration was the greatest contributing factor, accounting for approximately 65% of the population growth. It is expected that Saskatchewan will welcome 10,000-12,000 new immigrants annually, continuing through the foreseeable future. These numbers reflect a noticeable trend since 2009, as seen in Figure 2, much of which is accounted for by the province's increased role in economic immigration (Government of Saskatchewan, 2015).

The average age of male and female immigrants to Saskatchewan in 2013 was 26.1 years; with 27.6% of individuals aged 0 to 14 and 62.9% aged 15 to 44 – the age groups most relevant in terms of this review (Government of Saskatchewan, 2015).

Official language ability is self-declared by immigrants during their application process for permanent residence in Canada. Between 2011 and 2013, the percentage of total immigrants to Saskatchewan that spoke English remained constant at 72%, and the percentage of immigrant French speakers remained below 1%. If the language ability of only the principal applicants to the provincial nominee program is examined, rather than principal applicants plus their spouses and children/dependents, the results show that approximately 92% of provincial nominee principal applicants speak English, French, or both languages. The English language ability of all groups (total immigrants, nominees, nominee principal applicants) improved over the period 2009-2013 (Government of Saskatchewan, 2015).

Figure 2: Saskatchewan Immigration, 2002-2013 (Government of Saskatchewan, 2015)



The majority of electronically-accessed health information in Canada is communicated in English or French. The fact that most immigrants and refugees to Saskatchewan speak English is important in the context of this review, as most prenatal eHealth and mHealth tools are offered only in English (other language offerings will be noted as appropriate).

3.1.4 Aboriginal Populations

New data from the 2011 National Household Survey (NHS) shows the Saskatchewan population of self-identified Aboriginal peoples was 157,740 individuals, or 15.6% of the total population. This was the second-highest proportion among provinces, following Manitoba. In the 2011 NHS, the median age of self-identified Aboriginal peoples living in Saskatchewan was 22.6 years, significantly lower than for non-Aboriginal peoples at 40.9 years. For First Nations people in the province, the median age was 20.4 years, while for Métis persons it was 28.0 years. Additionally, in 2011, 53,780 Aboriginal peoples in Saskatchewan were under the age of 15, or 34.1% of the total Aboriginal population. Among the non-Aboriginal population, there were 142,475 individuals under the age of 15, or 16.7% of the population – significantly less (Saskatchewan Bureau of Statistics, 2011).

In Saskatchewan, there is a significant Aboriginal population, which may impact the overall pregnancy rate. Aboriginal fertility rates are much higher than the general population. When compared to the general population, adolescent pregnancy is four times higher among Aboriginal adolescents, 12 times higher for Inuit adolescents, and 18 times higher on federal land reserves (Saskatchewan Prevention Institute, 2014).

The comparatively young and large Aboriginal population in Saskatchewan presents a unique opportunity for prenatal eHealth education and support. The combination of a youthful population and high birth rates fit very well with the typical demographic using prenatal eHealth and mHealth tools. Further, the majority of Saskatchewan's Aboriginal residents live in the north, which contributes to issues with access to services. This report will identify culturally-appropriate prenatal eHealth tools that may address any unique needs of this population.

3.2 Technology Adoption

The presence and impact of electronic information technology is rapidly spreading throughout all areas of Canadian society, and Canadians are enthusiastic adopters. This is important, because the introduction of prenatal eHealth tools will only succeed if the electronic infrastructure is well established, and a high percentage of the population may be viewed as 'technology-literate'.

3.2.1 Internet Usage

Internet usage in Canada is among the highest in the world (The World Bank, 2014). Internet services may be accessed via computer, mobile phone, personal digital assistant, gaming machine, digital TV, etc. (The World Bank, 2014).

Canada is one of the most 'wired' countries in the world. With nearly 87% of Canadian households connected to the Internet, Canada ranked 16th globally in terms of Internet penetration (the degree to which a product or service is known and/or used) in 2013. This is up from 80% in 2010. Among its G8 counterparts, Canada ranks second in Internet penetration, behind only the United Kingdom (Canadian Internet Registration Authority [CIRA], 2015).

Although Canada is among the most connected countries in the world, a number of 'digital divides' exist within its borders and inequities relevant to this review are listed below:

i. 95% of Canadians in the highest income quartile are connected to the Internet, yet only 62% in the lowest income quartile have Internet access.
ii. Internet access varies by province. According to Statistics Canada's Canadian Internet Use Survey (2013), British Columbia and Alberta lead the nation in household Internet access with 86%. Household access is lowest in Quebec with 78%, and the east coast, Prince Edward Island with 78% and New Brunswick with 77% (Table 2).
iii. Whereas Broadband (High-Speed) Internet is available to 100% of Canadians living in urban areas, only 85% of Canadians in rural areas have access (CIRA, 2015).

The 'digital divide' is an economic and social inequality concerning the access to, use of, or impact of information and communication technologies. This division within countries may refer to inequalities between individuals, households, businesses, or geographic areas, usually at different socioeconomic levels or other demographic categories (MIT Technology Review, 2011). It is important that health service providers are aware of this inequity when offering recommendations to clients that require Internet access.

Table 2: Internet Access by Province (Statistics Canada, 2013)

	2010	2012
Canada	79%	83%
Newfoundland and Labrador	74%	79%
Prince Edward Island	73%	78%
Nova Scotia	77%	80%
New Brunswick	70%	77%
Quebec	73%	78%
Ontario	81%	84%
Manitoba	73%	80%
Saskatchewan	76%	83%
Alberta	83%	86%
British Columbia	84%	86%

Canadians have long led the world in Internet usage. This trend continued in 2013, with Canadians visiting more web pages per month (3,731), than any other country. Canadians also ranked a close second behind the United States for the average number of hours spent online per user (41.3 hours per month). The global average of pages visited per month by user was 2,278 in 2013, and the average number of hours spent online by user in 2013 was 24.6 per month (CIRA, 2015). Canadians also continue to be heavy consumers of online video (CIRA, 2015), ranking second behind the United Kingdom for average hours per month (24.8 hours) and average number of videos watched per month (291).

3.2.2 Mobile Phone Usage

While Canadians have generally been early adopters of technology, this was not the case for mobile, until recently. This was likely due to the robust landline telecommunications infrastructure that exists in Canada; however, mobile usage (especially smartphones) has been steadily increasing among Canadians. In 2013, Canadians were not unlike their global counterparts (Statistics Canada, 2014):

i. Six in 10 Canadians accessed the Internet via a mobile device in 2013.
ii. Mobile subscribers grew by 10% over the previous year, increasing to more than 22,000,000.
iii. Smartphone ownership has increased to 57% in Canada, well above the global average of 42%.

Total cell-phone use, whether used exclusively or in combination with other types of phone service, continues to grow in popularity in Canada. In 2013, 83% of Canadian households had an active cell-phone, up from 78% in 2010 (Statistics Canada, 2014).

Differences in total cell-phone use were observed across provinces. The proportion of households with an active cell-phone was highest in Alberta (91%), Saskatchewan (86%), British Columbia (85%), and Ontario (85%). In Atlantic Canada, the proportion of households with an active cell-phone was 80% in all provinces. The proportion was lowest in Quebec, at 76% (Statistics Canada, 2014).

The majority of Canadians use their smartphone for accessing the Internet (82%), but texting remained the top activity performed on their device. The top five activities performed on a smartphone by Canadians include the following:

i. Texting (93%)
ii. Taking photos/videos (91%)
iii. Browsing the Internet (82%)
iv. Calendar functionality (77%)
v. Applications (77%)

Certain activities, like watching video on a mobile device, are increasing rapidly. In fact, the percentage of smartphone users in Canada that use their device to watch video or television increased by 21 percentage points since 2012, to 37% in 2013 (Statistics Canada, 2014).

More than one in five households in Canada have cell-phones as their only form of telephone service (Figure 3). In 2013, 21% of households reported using a cell-phone exclusively; up from 13% in 2010. Exclusive cell-phone use is more pronounced in young households where all of the members are under 35 years of age. In 2013, 60% of these households reported using a cell-phone exclusively; up from 39% in 2010 and 26% in 2008 (Statistics Canada, 2014).

3.2.3 Coverage

Saskatchewan is well served by the major Internet and mobile service providers in terms of coverage. Not unexpectedly, both coverage and the quality of services offered are greater in urban areas and areas of Southern Saskatchewan. These patterns are very similar regardless of the provider; SaskTel, Bell, Telus, Rogers, Fido, and Koodo all demonstrate very similar patterns of coverage and services (Compare Cellular, 2015).

For the purposes of this review, Internet and mobile communications services can be viewed as very good to excellent overall in those areas; certainly sufficient to provide services to the majority of individuals that might be interested in prenatal eHealth tools. Reduced Internet and mobile device coverage can be a significant challenge to those living in Northern Saskatchewan or other remote areas as seen in Figure 3. Healthcare providers must consider this important reality when recommending eHealth tools.

Currently, coverage could be described as a limited patchwork of services in the North; however, there are commitments to improve the current situation (Government of Canada, 2015). In July of 2015, Industry Canada announced the Government of Canada would provide Saskatchewan Telecommunications (SaskTel) with a total of $7.42 million to connect nearly 2,700 homes in northern Saskatchewan to faster Internet services. This broadband infrastructure project is expected to be completed by the end of June 2017, delivering Internet download speeds at a minimum of five megabits per second (Mbps) – high speed Internet. The communities and surrounding areas to be connected in Northern Saskatchewan are the following: Bear Creek, Black Lake, Brabant Lake, Dillon, Canoe Narrows, Clearwater River Dene Nation, Dore Lake, Far, Fond du Lac, Grandmother's Bay, Jans Bay, Missinipe, Patuanak, Red Earth, Shoal Lake, Sled Lake, Southend, Stanley Mission, St. George's Hill, Stony Rapids, Sucker River, Turnor Lake, Wadin Bay, Wahpeton, Waterhen Lake, and Wollaston Lake.

3.2.4 Key Points

Recent statistics have clearly shown Canadians to be highly technologically literate, well supported with the required infrastructure, and enthusiastic users of both Internet and mobile communications technologies. These facts bode very well for the recommendation, introduction, and use of prenatal eHealth tools across Saskatchewan.

Of note, Saskatchewan has the second highest percentage of households with an active mobile phone, and the most common uses are texting and viewing videos. This has significant positive implications, considering that smart-phones are becoming the preferred method of delivering consumer or personal health information electronically, and most often through text or short-video messaging (American Journal of Preventive Medicine, 2013).

Internet and mobile coverage is not equally available across Saskatchewan and represents a clear health and social inequity in the context of this review. There are vulnerable populations living in Saskatchewan that could benefit greatly from prenatal eHealth tools; specifically those living in remote communities (e.g., Northern Saskatchewan), with limited access to regular prenatal care, and/or, with limited financial means. There are strategies to address this so-called 'digital divide', and will be discussed in the recommendations section of the review.

3.3 Assessing eHealth and mHealth Informatics Tools

Electronically-accessible health information can be extremely useful and empowering, assisting individuals with making important health decisions. However, health information can also be confusing and overwhelming, especially without the ready guidance of a knowledgeable healthcare professional. Given the abundance of information available electronically through the Internet and mobile devices, it is important to be able to assess the quality of that information. The evaluation of prenatal eHealth tools is no different. However, evaluation of information-based tools can be challenging as information is constantly changing as a result of new research, and there may be different, yet equally valid approaches to optimizing the health of an individual. Although there is no simple rule to determine the validity of online and mobile health information, there are guidelines that can be used to assess information credibility and accuracy (University of California – San Francisco, 2012).

According to a 2013 survey commissioned by Canada Health Infoway, more than 95% of Canadians surveyed believe it is important the healthcare system makes use of digital health tools and capabilities (Canada Health Infoway, 2014). This level of support for digital tools reflects the high degree of integration of mobile devices such as smartphones and tablet computers into everyday life, and the rapid growth of the digital health market. In 2013, there were approximately 100,000 health and wellness apps available on the iPhone, Android, and Blackberry platforms (Kamerow, 2013), though recent research suggests the evidence is mixed concerning the impact of mobile devices and apps on patient outcomes (Free et al., 2013).

There are several important factors that must be considered in the evaluation of eHealth tools before they can be recommended. Because these tools are responsible for the delivery of health information, they must be held to a very high standard. The implications of a failure in even one of these factors in a medical environment carry significant negative consequences. Such challenges highlight the importance of *Internet and app literacy* for the user and the health provider recommending or advising on the use of any particular tools.

3.3.1 Regulation of eHealth and mHealth

The regulation of both eHealth and mHealth tools is complicated, and made especially difficult by the fact that access to online information and tools are generally very difficult to restrict; electronically available health information is 'borderless'. Medical apps may be developed in any number of countries, may be located and stored on servers anywhere in the world, and are then available to people regardless of their physical location. Regulations in one jurisdiction often do not apply in another, or are impossible to practically enforce (Ontario Medical Review, 2014).

Online health information and tools are not evaluated or regulated in Canada. This is also true globally. There are numerous guidelines and recommendations for assessing the quality of this information, but a framework for removing information judged as inaccurate or misleading does not exist. A *caveat emptor* – buyer beware – approach needs to be taken toward health information found online, and thought given to its limitations (Ontario Medical Review, 2014). Even with regulation, enforcement would be nearly impossible given the rapid proliferation of online content. *Recommendations by a Subject Matter Experts (SMEs) are typically considered the gold-standard by healthcare professionals*.

The regulation of medical apps (mHealth) has been the focus of greater attention, though at this time there are no common standards, and no organization was found to house an established list of carefully selected, trusted, and recommended healthcare apps (Boulos, Brewer, Karimkhani, Buller, & Dellavalle, 2014). North America and Europe currently develop the majority of health apps used by consumers in Canada. Under current Health Canada guidance, apps are regulated as medical devices *when they replace a diagnostic or treatment decision made by physicians* (Canada Health Infoway, 2014). The U.S. Food and Drug Administration (FDA) guidelines indicate that it will evaluate apps that are "used as an accessory to a regulated medical device; or transform a mobile platform to a regulated medical device," but will exercise "enforcement discretion" (meaning not always enforce) for apps that "pose less risk" – which is the vast majority of apps available (Ventola, 2014). Medical apps that "pose less risk" are those that do not claim to make a diagnosis, or those that do not claim to treat a condition. Similarly, the Medicines and Healthcare Products Regulatory Agency (MHRA) in England states "if an app is purely a record archiving and retrieval system, it is unlikely to be considered a medical device; however, if

it includes a module that interprets data or performs some calculation, then it is likely that this particular component may be considered a medical device. An app performing simple and straightforward calculations should not be treated as a medical device" (Boulos et al., 2014).

Many have complained that these guidelines are vague and confusing, offering little true guidance. The mobile health application industry is still in its infancy. Existing laws and public regulations for approving health-related apps are only relevant to a rather small number of apps. Various reasons, including the number of functionalities, diversity of information, and rapid development of health-related applications in the market, make certification difficult to achieve (Yasini & Marchand, 2015).

It has been proposed that government or health agencies should provide a proper vetting of medical apps before they are offered to the public through the various app stores, such as Apple iTunes or Google Play. The assigned agency would be tasked with assessing and ensuring the quality of these apps from a medical/health point of view. This is in addition to the technical assessment of submitted apps, to determine if they behave as intended, without crashing the devices running them, and where applicable, if they are secure and protect user's privacy. These are not trivial tasks, and could prove very demanding and well beyond the current capabilities of any agency when one considers the tens of thousands of medical and health apps currently available (Boulos et al., 2014).

It is also important to note that the app stores themselves do not evaluate the effectiveness of the health and medical apps on their sites. Major platforms for mobile applications (Google Play store and Apple store) provide consumers the ability to rate the apps. Users can rate the apps by giving them a mark out of five stars; hardly a rigorous evaluation process. Both Apple and Google typically decline to discuss anything about their apps, or the app development process. Both companies issue lengthy guidelines for app developers, which say they will reject apps that crash, have bugs, do not perform as advertised (stated exceptions allowed), and include content guidelines that ban sexually explicit material, gratuitous violence, or anything that may damage users' devices (New England Center for Investigative Reporting, 2012). User complaints often drive this process.

3.3.2 Assessing Health Information – Online Sources

Every day, millions of Canadian consumers search for and access health information online. Some health information is reliable and accurate, but much is not. Locating information on the Internet is only the first step in health information seeking, and is typically the quickest and easiest step. Assessing the quality of accessed information is the next step, and is often a much more difficult task. Not only can it be a waste of time to read through a site and implement the information and suggestions found there, only to later find that they were inaccurate or not based on the most recent research, but such sites may pose a significant health or safety risk if that information negatively affects the health and safety of the individual (HLWIKI International, 2015).

In a recent Canadian study, when pregnant women were asked where they get information about pregnancy, 89% of respondents reported their healthcare provider as a source of information, closely followed by websites (84%), family and friends (81%), and books (79%). The value of the healthcare provider was further confirmed when survey respondents were asked to rate the usefulness of these sources. Healthcare providers were identified by 48% of survey respondents as their most useful source, compared to websites by 21%, family and friends by 13%, and books by 8%. The literature review completed for this study aligns with these survey findings, where websites and healthcare providers were identified as a common source of pregnancy-related information (Wellington-Dufferin-Guelph Public Health, 2013).

There are numerous sources of credible advice, guidelines, and recommendations discussing what to look for in assessing the quality of online health and medical information. An excellent Canadian source is provided by the Canadian Public Health Association (2015), outlined in Figure 3.

Figure 3: Assessing Online Health Information (Canadian Public Health Association, 2015)

1.	When looking for health information online, keep in mind that the Internet is not regulated. Anyone can set up a website.
2.	Does the website say who is responsible for the information and how you can contact them? Look for links that say about us, about this site, or contact us. If you can't find out who runs the site and how to contact them, you should be suspicious.
3.	Is the purpose of the website to give information, or is it to trying to sell you something? Commercial websites might be giving only information that supports what they are selling and not a balanced view.
4.	You can usually get reliable health information from non-profit educational or medical organizations and government agencies. Health information should be unbiased and balanced, based on solid medical evidence and not just someone's opinion.
5.	The most trustworthy health information is based on medical research. Does the website give references to articles in medical journals or other sources to back up its health information?
6.	Health information for the public should be easy to understand. Technical or unfamiliar terms should be clearly explained. Websites should also tell you when the information was prepared and updated.
7.	Ask a doctor or other health professional about the health information you find on websites. You may want to bring a copy of the information with you.
8.	Be careful about providing personal information. Some websites collect and sell your personal information to other organizations.
9.	Trust your instincts about the health information you find on websites. If it doesn't seem reasonable and believable, then don't use it.

3.3.3 Assessing Health Information – Mobile Devices (Apps)

Smartphones have revolutionized the communication landscape. Almost 'always on' and highly portable, smartphones provide real-time, on-demand communication, and their rich multimedia touch-displays operate with increasing speeds, delivering data services, and computing power to document and improve the networked lives of their owners. The mobile revolution is offering an unprecedented opportunity to provide medical support when and where people need it. Large numbers and varieties of health information apps exist on the market today. From basic apps composed of text message reminders to apply sunscreen, to sophisticated apps that coordinate the management of diabetes, apps play a multitude of functions in health and healthcare (Boulos et al., 2014).

Unfortunately, many users are unaware of the risks and limitations that arise from the use of health-related and medical apps in a medical context. Often, problems arise from insufficient, misleading, or false information, but they also arise from errors within the app or inappropriate hardware that is used for running the app itself. Provided information is often inadequate to enable users to assess whether a medical or health app

is reliable and safe. Laws and regulations that are meant to provide consumer safety (for patients and medical professionals alike) only apply to a limited number of apps with a specific medical purpose. For non-regulated apps used in a health context, there are various projects and initiatives, for example relating to app certification, but not all of these provide the information they collect about an app in a comprehensible and verifiable manner (Hannover Medical School, 2014).

As mentioned previously, relatively few studies exist on the effectiveness (clinically and financially) of mobile health and medical smartphone apps; more research is needed to properly address this issue. Assessment of some aspects of specific apps or types of apps may require a full-blown clinical trial or evaluation study and the necessary resources to conduct it, which is well beyond what can be evaluated by a single person or a few people using a checklist of criteria to look for (Boulos et al., 2014).

Mobile technology has several potential advantages for providing actionable medical advice, but also has its own limitations and potential problems associated with it. App developers come from a wide range of backgrounds, and studies have demonstrated that some medical apps use information without appropriate citations of supporting evidence. One of the most common problems is medical app development without input from medical professionals, and until mHealth regulation, standardization, and enforcement becomes a reality – *buyer beware* (Ontario Medical Review, 2014).

Given the overwhelming proliferation of apps, how can healthcare professionals and the public identify the most appropriate mHealth tools? There is no easy answer. Because of the enormous range of quality among health and medical apps, strategies for evaluating them are necessary for adoption to occur in a way that aligns with core values in healthcare, such as the Hippocratic principles of nonmaleficence (a principle of bioethics that asserts an obligation not to inflict harm intentionally) and beneficence (the doing of active goodness, kindness, or charity, including all actions intended to benefit others) (Boudreaux et al., 2014).

Recommendations from several sources (Boudreaux et al., 2014; Wicks & Chiauzzi, 2015) useful for the selection of mHealth apps are summarized in Figure 4. The numbers in the left column indicate the order of recommended steps. It is strongly recommended that healthcare providers review these steps prior to recommending an app to a patient.

Figure 4: Identifying and Assessing Apps (Boudreaux et al., 2014; Wicks & Chiauzzi, 2015)

Step	Activity
1.	• Review the scientific literature. • Search the scientific literature for papers reviewing apps in a specific content domain or demonstrating strong clinical trials.
2.	• Search the app stores. • App stores are challenging to navigate, so it is important to fine-tune and filter app searches with the most relevant and targeted key words, including words keyed to the pathological state or target behaviour. • Individuals can select apps by navigating online marketplaces such as the Apple iTunes App Store or the Google Android Play Store on their smartphones. Health and medical apps are usually categorized in the "Medical" section, with the most frequently downloaded apps listed in the "Top Free" and "Top Paid" categories. • The search option is not always efficient, as apps are classified based on the app's name or key description provided by the developer, not always based on their purpose.
3.	• Review app descriptions, user ratings, and reviews. • Publicized ratings and user reviews can offer evidence of app usability, functionality, and efficacy, which can help to narrow the pool of candidate apps. • Users can further screen apps by performing a search using topic-related search terms; however, this approach is fraught with challenges. The frequency of downloads is not a reliable indicator of the quality of the app. • User ratings and reviews must be viewed with caution.
4.	• Conduct a social media query within professional and, if available, patient networks. • Social networks may reveal new app trends, likability by certain user groups, and other substantive data. • Peer-reviewed recommendations such as third-party organizations have emerged to offer peer-reviewed recommendations on apps. • Apps can also be selected based on information from resources such as online news sites, professional conferences, recommendations by health delivery organizations, and word-of-mouth recommendations from trusted sources.
5.	• Pilot the apps. • This is a key step! • Must involve the Subject Matter Experts (SMEs). • Apps may be piloted by the healthcare provider or a designee, including examinations of functionality, accuracy of content, and usability. • The importance of this step cannot be emphasized enough.
6.	• Elicit feedback from patients. • Patients may be able to provide valuable insights after they have used the app a healthcare provider or client recommends.

In order for medical/health apps to evolve, improved oversight and continuous quality review is required. Centralized oversight by regulatory bodies has the advantage of

regulatory expertise and powers to sanction. However, these regulatory bodies are too under-resourced to wade through the sheer volume of apps, and there appears to be little appetite in either North America or Europe to get involved (Wicks & Chiauzzi, 2015).

Mobile platforms for health information delivery have been described as the way of the future; the ubiquity of mobile use has been associated with a corresponding uptake in the use of mobile health technologies. While the regulation of medical apps remains a grey area, healthcare professionals and users will need to elevate their "app literacy". With thousands of health apps in the marketplace, healthcare providers and healthcare organizations need guidance on identifying apps that are effective, provide accurate information, and are user-friendly. In addition, more primary research is needed to establish evidence for health apps efficacy. Patients and caregivers are likely to have unique insights into the behaviour or disease area, and are likely to rely on piloting (try before you buy) the app to determine its utility and effectiveness (Boudreaux et al., 2014).

3.4 Saskatchewan Prenatal eHealth Resources

Saskatchewan offers a wide variety of prenatal healthcare services and education (in person, printed, and electronic information) through the 13 health regions and affiliated organizations. The regional health authorities (health regions) provide most prenatal health services in Saskatchewan, either directly or through affiliated healthcare organizations (Government of Saskatchewan, 2015).

Of the 13 health regions in Saskatchewan, four of them offer eHealth prenatal services in the form of online prenatal classes. The four health regions are Five Hills, Saskatoon, Prince Albert and Sunrise.

The Five Hills Health Region offers online prenatal classes at no cost to residents (http://www.fhhr.ca/PrenatalClasses.htm). Prenatal information is not specific to Saskatchewan and was developed by a Colorado company, *InJoy Birth & Parenting Education* (InJoy, 2014).

The Saskatoon Health Region offers an online prenatal class, with unlimited access from home for 60 days (https://www.saskatoonhealthregion.ca/locations_services/Services/Prenatal-Education). There is a $50.00 fee per couple for the series. *Baby's Best Chance*, a comprehensive parenting book, is provided to each participant at no additional cost (e-version for on-line classes). The prenatal information is not specific to Saskatchewan and Saskatoon Health Region also uses the Colorado company, *InJoy Birth & Parenting Education* (InJoy, 2014).

Like the Saskatoon Health Region, the Prince Albert Parkland Health Region offers an online prenatal class with unlimited access from home for 60 days (http://paphr.ca/services/public-health-services/prenatal-information). There is a $50.00 fee per couple for the series. The Baby's Best Chance book is provided to each participant at no additional charge. Prince Albert Parkland also uses the Colorado company, *InJoy Birth & Parenting Education* (InJoy, 2014)

prenatal program. Although the content is not Saskatchewan specific, there is an "Ask a Nurse" tab available to mothers that connects them to a local Registered Nurse from the Health Region's Prenatal Team.

The Sunrise Health Region offers an online prenatal program, the *eLearning Prenatal Program – The Gift of Motherhood* at no cost to residents (http://sunrisehealthregion.sk.ca/default.aspx?page=55). This online prenatal program is not specific to Saskatchewan. The prenatal information is developed and sold by the Texas company, *Customized Communications, Inc.*

3.5 Prenatal eHealth and mHealth Tools Ready-For-Use

If healthcare providers are interested in utilizing and recommending eHealth and mHealth tools to their patients, the first option available is to evaluate and recommend prenatal eHealth and mHealth tools already developed and currently available for public use. These tools can be described as stand-alone and require no additional support from healthcare service providers in Saskatchewan. These tools are generally made available to the public as-is, and cannot be modified aside from a few customer preferences.

3.5.1 eHealth

The eHealth tools listed here are based on the evaluation criteria described in section 3.3.2. Because there are many prenatal care websites to choose from, this review will focus on those with Canadian content, and content specific to Saskatchewan, where possible.

The eHealth resources listed have not been evaluated for content. The author of this report is not an expert in prenatal education or healthcare. A prenatal Subject Matter Expert should review these sites before recommending to clients.

Examples from the Government of Canada, provincial governments, and professional organization websites that meet the criteria specified in section 3.3.2 include the following. This should not be considered an exhaustive list. All resources are available without charge or geographic restrictions.

a) A Healthy Pregnancy is in Your Hands
Public Health Agency of Canada
http://www.phac-aspc.gc.ca/hp-gs/index-eng.php

b) Healthy Pregnancy
Health Canada
http://hc-sc.gc.ca/hl-vs/preg-gros/index-eng.php

c) Having a Baby
Service Canada
http://www.servicecanada.gc.ca/eng/lifeevents/baby.shtml

d) Guide to Healthy Pregnancy
Government of Canada
http://www.healthycanadians.gc.ca/healthy-living-vie-saine/pregnancy-grossesse/general-information-renseignements-generaux/health-guide-sante-eng.php

e) Prenatal Nutrition
Health Canada
http://www.hc-sc.gc.ca/fn-an/nutrition/prenatal/index-eng.php

f) Canada Prenatal Nutrition Program (CPNP)
Public Health Agency of Canada
http://www.phac-aspc.gc.ca/hp-ps/dca-dea/prog-ini/cpnp-pcnp/index-eng.php

g) Pregnancy
The College of Family Physicians of Canada
http://www.cfpc.ca/projectassets/templates/resource.aspx?id=1412&langType=4105

h) Clinical Practice Guidelines
The Society of Obstetricians and Gynecologists of Canada
http://sogc.org/clinical-practice-guidelines/

i) During Pregnancy (Prenatal)
Saskatchewan Prevention Institute
http://www.skprevention.ca/prenatal-health/

j) Birth and Babies: Online
Alberta Health Services
http://online.birthandbabies.com/

k) First Nations and Inuit - Healthy Pregnancy
Health Canada
http://www.hc-sc.gc.ca/fniah-spnia/famil/preg-gros/index-eng.php

l) Maternal, Child, and Family Health

First Nations Health Authority
http://www.fnha.ca/what-we-do/maternal-child-and-family-health

m) Aboriginal Prenatal Health

Best Start
http://www.beststart.org/cgi-bin/commerce.cgi?search=action&category=AB1A&advanced=yes&sortkey=sku&sortorder=descending

n) Aboriginal Nutrition

Dietitians of Canada
http://www.dietitians.ca/Dietitians-Views/Specific-Populations/Aboriginal-Nutrition.aspx

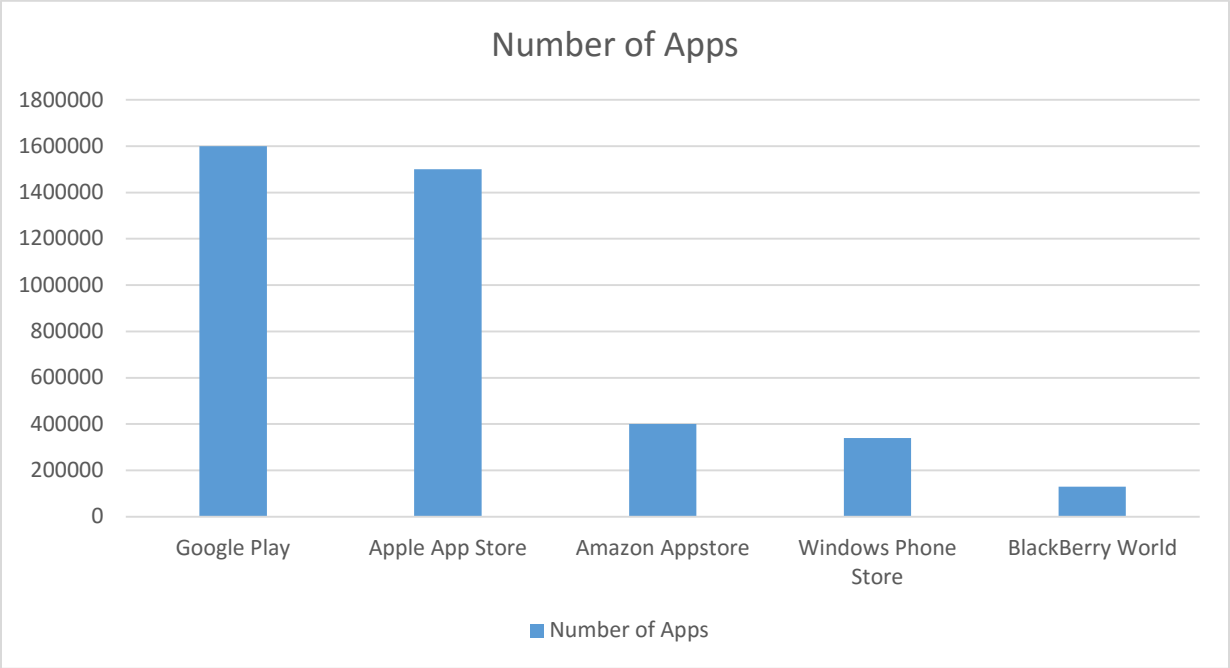
3.5.2 mHealth

A comprehensive analysis of all pregnancy-related smartphone apps in the two major app stores, the Apple App Store and Google Play store, was conducted in July 2015 (Lupton & Thomas, 2015). The search was limited to these two platforms because Google's Android and Apple's iOS operating systems have a combined market share of 91% of apps (Figure 5) installed on mobile devices (Statista, 2016). Also, a significant majority of titles are shared between platforms, making an analysis of all stores unnecessary (Lupton & Thomas, 2015).

A search for all pregnancy-related apps offered in these two stores used key search-terms such as pregnancy, prenatal, childbirth, conception, ovulation, birth, maternal, fetus, and baby. After eliminating apps listed in these searches that were not relevant, researchers narrowed their search to the remaining 665 apps on Google Play and 1,141 in the Apple App Store, with many of those apps shared across the stores (Lupton & Thomas, 2015).

Narrowing the search using the keyword *prenatal* still resulted in over 250 apps and 250 eBooks in the Google Play store alone. It is difficult to recommend prenatal apps or eBooks considering the volume of electronic prenatal information, particularly without an existing regulatory body, or standardized evaluation framework, even with the evaluation criteria described in section 3.3.3. Despite these challenges, with careful selection and evaluation appropriate recommendations are possible.

Figure 5: Total Number of Apps Available across all Platforms (Statista, 2016)



As noted previously, the author of this report is not an expert in prenatal education or healthcare. A prenatal Subject Matter Expert should review any apps or eBooks before recommending to clients.

3.6 Prenatal eHealth and mHealth Tools Requiring Development or Adaptation

The second option available to those looking to provide prenatal electronic information for expecting parents in Saskatchewan is to develop a new, or adapt an existing, prenatal eHealth or mHealth tool locally. This would allow for the development of prenatal eHealth or mHealth tools that speak directly to the needs of Saskatchewan residents. This option would require a serious commitment of time, expertise, and financial resources to ensure success. A partnership between government, Health Regions, local colleges or universities, and interested corporations would be ideal depending on the level of functionality desired.

This project would be a complex undertaking, requiring a team of dedicated healthcare professionals with strong knowledge of prenatal health, and computer scientists with expertise in Internet and/or mobile app development. Additionally, once a prenatal eHealth or mHealth tool is developed, it must be supported; the tool would need to be hosted on a local server(s), information will need to be regularly updated, and there would be a requirement for on-going development, maintenance, and security. This project would require funding from some level of government, corporate, or private sponsorship; however, there are options discussed below which can significantly reduce costs and foster success.

It is important to note that the Prevention Institute has already developed a strong eHealth (website) and mHealth (app) presence. This is a significant strength that can be leveraged in the development of a unique, content-specific prenatal eHealth and/or mHealth tool.

The Prevention Institute has an established website (http://www.skprevention.ca/) and a recently created Saskatchewan-specific electronic prenatal resource. In 2015/2016, the Prevention Institute created this online prenatal resource presenting evidence-based prenatal information using clear, plain language and a simple, easy-to-follow structure. The prenatal online resource "Your Pregnancy Month by Month" was created to meet the need for prenatal information among all Saskatchewan women, including those with lower literacy skills and those living in challenging circumstances that can lead to increased risk to their health and the health of their babies. Once the resource was developed, it was important to evaluate how well the resource met the needs of the intended users, and to adapt and revise the resource where possible to better meet their needs. Focus groups were held in Northern and Southern Saskatchewan, with communities ranging from urban to rural and remote. Overall, the response from the focus group participants was very positive. The majority of women were happy the resource had been created and felt that it was well laid out. The majority of mothers also found the resource to be comprehensive, easy to understand and navigate through, and found the information useful. The majority also stated that they would use the resource again and recommend it to others. When asked what would make it more or less likely that they would use the resource in the future, many responded that they would make use of the website as it is. A few women expressed that creating an app would be appreciated, as they tend to use apps more than websites, particularly on their phones. When it was shared that the Prevention Institute is looking at the possibility of creating an app that has GPS capability, so that it could let women know what services were available in their community, there was a very positive response to this.

The Institute has also created a smartphone app, *Keep it Safe Saskatchewan* (Saskatchewan Prevention Institute, 2015), which is focused on adolescent reproductive health, contraceptives, and STIs. This previous experience with app development assists with planning and budgeting. Information can be found at http://www.skprevention.ca/keep-it-safe-saskatchewan/.

3.6.1 Hacking Health

Hacking Health (HH) is a social organization that pairs innovators with healthcare experts. The goal of HH is to build solutions for front-line healthcare problems through the use of emerging technology. Held over a weekend, HH 'hackathons' consist of 200-300 participants where computer designers and developers collaborate with doctors, nurses, clinic managers, and other healthcare professionals to develop prototypes that can be put to test in clinics and hospitals. The event also attracts industry professionals, venture capitalists, and entrepreneurs. The hypothesis is that the interface of front-line clinicians and technology experts will yield innovative approaches to some of healthcare's most entrenched problems by rapidly building and testing prototypes. The goal is to make this

experimentation as low risk as possible for everyone involved (Hacking Health, 2015). More information may be found at http://hackinghealth.ca/.

HH is an opportunity for healthcare professionals to pitch ideas to computer designers and developers. Cities across Canada, including Saskatoon, host an HH event each fall.

Hacking Health is a viable option should the development of a Saskatchewan-specific prenatal eHealth or mHealth tool be chosen as the best route to proceed. Many successful eHealth and mHealth tools have been developed through this program. Limitations include infrequent Hacking Health events in Saskatchewan, intellectual property ownership issues, financial considerations, and the possibility this app will not generate significant interest among developers.

3.6.2 Yukon Baby

The Yukon Baby app was conceived at the HH North event in May 2014 by a family physician, software engineer, genetic counsellor, early childhood educator, and midwife (Yukon Baby, 2015). A multi-disciplinary team made up of health professionals and software developers is valuable when developing a successful healthcare app. Yukon Baby (Figure 6) is a phone-based app aimed at women, men, and families, providing information on pre-pregnancy, pregnancy, and early childhood. The vision is to initiate and support healthy human development by engaging families in their child's health during these critical periods that lay the groundwork for their futures. Financial support for the app was provided mainly by Technology Innovation at the Yukon College Research Centre and by the Yukon's Department of Health and Social Services (S. Ryan, personal communication, April 27, 2016). The creators of Yukon baby have partnered with the Yukon Government – Health and Social Services, Technology Innovation at the Yukon Research Centre, and Partners for Children at Yukon College, for this project (S. Ryan, personal communication, April 27, 2016).

This free app can be downloaded through the Yukon Baby website (Android and Apple iOS versions) at www.yukonbaby.ca (Yukon Baby, 2016), from Google Play (Android version) at https://play.google.com/store/search?q=prenatal&hl=en (Google Play, 2016), or Apple (iOS) at https://itunes.apple.com/ie/app/yukonbaby/id1057023019?mt=8 (Apple App Store, 2016).

Future development includes translation into French and a dedicated website. After almost two years in development, the app was launched in February 2016 (S. Ryan, personal communication, April 27, 2016). The team is gathering feedback to continue to improve the many features in the app (S. Ryan, personal communication, April 27, 2016).

Figure 6: Yukon Baby Homepage (2016)

The Yukon Baby factsheet states:

> The Yukon Baby smartphone app will engage women, men, and their families and support them during pre-pregnancy, pregnancy, and early childhood periods. While many pregnancy and childhood-based apps exist, none are locally relevant and tailored to our northern communities. The app will increase awareness of evidence-based healthy practices such as folic acid intake and vaccination visits to ultimately improve pregnancy and childhood outcomes in Yukon, which in turn will reduce health system costs. The app will provide easy access to local resources, relevant health information, and tools to support health. *The project is being designed so that the content could easily be customized for use in other communities in Canada and internationally*. (Yukon Baby, 2015, p.1).

S. Ryan described the tools which includes a pregnancy timeline, community events calendar, frequently asked questions, and ways to track the health of a pregnancy, and the newborn period (immunizations, contraction timer, depression screen, and others (personal communication, April 27, 2016). Additional components are planned, which includes a kick counter, planning your birth section, and "bump" photos (S. Ryan, personal communication, April 27, 2016).

The online platform functions similarly to a content management system (CMS) and allows community providers a portal to update their information in the app. This and other information in the app is periodically updated to keep information relevant and current (Yukon College, 2014).

Recent discussions between the author of this report and founding members of the Yukon Baby project (Shannon Ryan, CFO and Co-Founder and Wes Wilson, CTO and Co-Founder) were positive and encouraging. This provides an excellent opportunity for the Prevention

Institute to follow the progress of Yukon Baby, learn from their experience, and explore the possibility of adapting Yukon Baby for Saskatchewan.

The development or adaptation of a prenatal app based on the Yukon Baby app is a viable option, should the development of a Saskatchewan-specific prenatal tool be chosen as the best route to proceed. The Yukon Baby technical team has indicated an interest in working with the Saskatchewan Prevention Institute should the Institute choose this option.

3.6.3 Commercial Development

The Saskatchewan Prevention Institute could choose to pursue the development of a prenatal information/education app or website with a local developer or development team. The advantages include expert development, efficient completion, and a complete package of services (development, testing, hosting, up-dating, and maintenance). This may be an option as the Prevention Institute has already established a website, and developed a healthcare app (Keep it Safe Saskatchewan), http://www.skprevention.ca/keep-it-safe-saskatchewan/, meaning that the industry contacts and much of the necessary infrastructure is already established.

The *NuuNest* app is an example of a locally-developed, successful, and well-respected app that provides post-natal information for the first few weeks after birth (including both the mother's recovery and baby care). The app was developed by two Registered Nurses who are International Board Certified Lactation Consultants, from Saskatoon. The Institute has been in contact with the co-founders, learning much from their experience. More information may be found at http://cindyandjana.com/nuunest-app/.

The commercial development of eHealth or mHealth prenatal tools is a viable option if adequate financial resources are secured.

3.6.4 Post-Secondary Partnerships

Colleges and Universities are often looking for opportunities for their students to take on projects in the community as part of their education, and will provide supervision by faculty. The Saskatchewan Prevention Institute could partner with a local college or University to pursue the development of a prenatal education app. The advantages include expert guidance from faculty, strong development from senior students, efficient completion (though based on the academic year schedule), and significant cost savings. Other services (development, testing, hosting, content up-dating, and maintenance) would have to be determined.

The development of an eHealth or mHealth prenatal app or website built in partnership with a local college or university is a viable option if faculty can be recruited for the project, and resources secured for on-going maintenance.

4. Potential Next Steps

Based on the findings of this literature review and environmental scan, potential future steps regarding eHealth and/or mHealth in Saskatchewan have been identified. These are potential initiatives that could be undertaken by the Saskatchewan Prevention Institute in collaboration with other interested stakeholders, to provide Saskatchewan residents access to important prenatal health information via electronic means. Doing one initiative does not preclude doing the other; however, as resources are limited, it is likely prudent to decide on a priority, putting available resources toward that.

4.1 Create a list of recommended eHealth and mHealth resources (acknowledging no Saskatchewan-specific resources were found)

This list could be shared with health professionals to facilitate them identifying the resource(s) they feel comfortable recommending to the prenatal women they work with.

- Prior to recommending any of the existing described eHealth or mHealth resources (sections 3.3.2 and 3.3.3), it is important for someone with strong prenatal knowledge and experience to review and evaluate the content of those resources as having met the initial criteria for assessing quality. For mHealth resources, this should include downloading the selected apps and eBooks. 'Dummy' accounts can be set up on each app at different gestational periods in order to assess all of the different text messages and information provided.

4.2 Develop or adapt an eHealth or mHealth tool specifically for Saskatchewan

This would ensure the information is specific and relevant to Saskatchewan residents (i.e., issues of concern to Saskatchewan residents, and locally available services and resources). There are two ways that this could be done:

- Develop the resource from the ground up. If this option is chosen, the most resource-efficient option would be to work in collaboration with a local college or university (this collaboration could include development, hosting, and ongoing maintenance). Additional partnerships from the health and government sectors could be sought in order to ensure the content and format was appropriate, useful, and that the resource was seen as legitimate.

- Adapt an existing resource that is available for adaptation. Similar to developing from the ground up, partnerships could be sought to ensure both technical aspects and content are of the highest quality. There are at least two good options available for adaptation. One is the recently launched Yukon Baby, described in detail in section 3.6.2. The developers of Yukon Baby have indicated their openness to sharing the platform for adaptation for other regions, at a cost to be determined. Another promising program is the Alberta Health Services program, Birth and Babies: Online, listed in section 3.5.1, as a model of online prenatal eHealth information and education. This program is available free of charge and

has no geographic or residency restrictions for participation. If Saskatchewan-specific content is desired, a similar prenatal education program could be developed by the Saskatchewan Prevention Institute with partnerships as described above.

5. Conclusions

Expectant parents in Saskatchewan deserve up-to-date prenatal information and are enthusiastic users of both Internet and mobile communications technologies. Saskatchewan residents are highly technologically-literate and are well supported with the required infrastructure in much of the province. The Saskatchewan Prevention Institute recognizes the need to adapt the way information is provided and acknowledges the trend towards the use of technology. Saskatchewan has multiple populations that could benefit from well-developed prenatal eHealth and mHealth tools.

Although there are many existing prenatal eHealth and mHealth tools available, no comprehensive prenatal tools were identified to be Saskatchewan-specific, and there is a lack of evaluation and regulation of tools world-wide. Anybody, anywhere in the world can develop an app and it can be accessed by anyone, anywhere. You do not need to be a Subject Matter Expert to develop an app. Furthermore, there is no enforcement mechanism in place to remove, or even warn the public about prenatal eHealth and mHealth tools that are inaccurate or dangerous. Guidelines are available for the evaluation of prenatal eHealth and mHealth tools, but no list of evaluated, reputable, quality prenatal technology-based tools was found.

Interested stakeholders in Saskatchewan have several options on how to address the gap in quality prenatal Saskatchewan-specific resources that could be recommended to expectant parents. The first option is to evaluate existing eHealth and mHealth resources and to compile a recommended list for healthcare providers to use with prenatal women. This option does not address the lack of Saskatchewan-specific websites or apps that are a “one stop shop” for important prenatal information. The second option is to adapt or develop an eHealth or mHealth tool specifically for Saskatchewan women. This could provide Saskatchewan women with a “one stop shop” that allows them to access community and provincial information and services. Incorporating GPS into the prenatal tool(s) could notify women of prenatal events, services, and contact information in their community.

Regardless of which option is chosen, effort should be taken to increase access to electronics that allow use of these tools. It is important to address access challenges by exploring options for providing electronic access opportunities. For example, communities/organizations could provide access to affordable tablets (there are excellent

Android options available under $150, and good options available under $50) that could be loaned or given to lower SES parents without a mobile device. Another option is to provide prenatal health information computer stations in health or resource centers.

It is essential that Saskatchewan stakeholders take a collaborative approach to determine the most appropriate next steps, and participate in the process of providing quality prenatal information using technology-based tools to all women in the province. By engaging stakeholders who are prenatal Subject Matter Experts in the decision-making process, it is more likely that they will continue to be involved, contribute to the process, and recommend what is created to their colleagues and the women they work with.

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