E-Health for people with diabetes

Adoption and use of diabetes self-management applications among diabetics in Bulgaria

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Abstract

The purpose of this thesis is to study the level of understanding of e-health applications among users with diabetes in Bulgaria, to find out how they use those applications, and to provide knowledge on what m-health applications provide to people with diabetes, and what they actually need. This research used TAM variables combined with Innovation Diffusion Theory to produce knowledge on technology acceptance. Therefore, the factors of relative advantage, compatibility, complexity, trialability and observability will be used to determine perceived usefulness, perceived ease of use and behavior intention to use a technology. This research was intended to gather information on the use of diabetes self-management mobile apps in a standardized manner. The instrument used for the survey, a questionnaire, aimed to provide information on the use and experience of mobile health apps for managing diabetes. The final online survey was completed by 71 participants, 38 of which were female, 28 were male and 7 were of non-specified gender. The introductory stage of the survey showed that most of the respondents were between the ages of 31 to 40 years old (28.2 %), and that the largest part of the population sample has been diabetic for five years (32.4%). By taking into consideration the results, it can be said that 74.6% of relative advantage correspond to very high perceived usefulness on behalf of the respondents. And a score of 53.5% shows that the people who took part in the survey exhibit high perceived ease of use of the mobile applications. This concludes that initially upon using diabetes self-management applications, the respondent’s exhibit high behavioral intention to do so and due to that the applications are not defined as complex, they are suitable for constant use.
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1 Introduction

Over the years, the advancement of new technologies and their innovative use in medicine, have contributed to the development of innovative ways for the provision of efficient healthcare. In particular, the use of information communication technologies has led to the development of e-health, which is becoming more and more integrated in the everyday life of the individuals.

E-health is defined as the use of technologies such as the internet and advanced devices to support healthcare needs (Jones et al., 2005), or more properly “e-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the internet and related technologies” (Eisenbach, 2001, p.3). This innovative approach to healthcare delivery has dramatically changed the current medical processes, because it allows patients data to be gathered and stored electronically. This plays an empowering role in the patient’s decision-making process regarding the treatment of health conditions.

Currently there is a lot of research performed on the use of different types of healthcare applications (Kiriacou et al., 2003; Voskarides et al., 2002; Ganz et al., 2006), and more is being produced, because the use of mobile devices for mobile healthcare are revolutionizing healthcare delivery (Olubukola & Ayeni, 2005). Such devices, paired with mobile applications and wireless internet, provide the ability for real-time update of medical records, ensuring that carers will make more accurate decision on possible treatments, thus reducing medical errors and delivery more effective patient care.

Due to the usability, availability and scalability of mobile technologies and applications, both patients and physicians will continue to adopt e-health technologies making them more prominent in the medical sector. In doing so, the field of e-health will expand to deliver better patient diagnosing, disease prevention and even efficiency on global levels (Ehikioya, 1997).

However, in order for the e-health system to be efficient, it must be designed according to the specific needs of the user (WHO, 2004). This means that e-health systems need to have the ability to be customized, which will positively impact their adoption. According to research (WHO 2004; Bhatia & Shrama, 2006), currently an e-health system provides medical education, systems for disease monitoring, distant consultation, diagnosing. Not only, does the system provide the patients with the ability to monitor their own health, but also provides them with faster and more efficient information.
Due to the emerging of new applications and technologies at rapid pace, e-health systems must be constantly evaluated in order to be improved and to have better usability. A way to find out how to improve the system is to evaluate several criteria (WHO, 2004-2007).

- The systems acceptability and usability by patients
- How it improves healthcare
- How safe it is to use by patients
- How cost effective and efficient it is
- Does it cope with health inequalities?

E-Health

The use and functions of e-health change and develop at a very fast pace. In 2002, Maheu studied the trend towards multiple technologies converging with the Internet, and in current healthcare settings we see the use of electronic patient records, instant messages between doctor-patient, remote health monitoring devices, and even electronic prescriptions. Neuhaser et al., (2003), went further to describe the benefits of e-health systems and the services they support, such as:

• The provision of access to wide variety of health-related information through internet
• The ability to communicate online in order to get support in reaching better informed decision on health problems
• Education of people on health problems, such as mental health prevention (www.healthyplace.com)
• Creating self-help groups in which to perform question-answer activities
• Online doctors who deliver services (etherapy)

All those services correspond to the idea that patients are becoming more and more active in supporting their wellbeing. Or as noted, patients are becoming participants in healthcare by using the internet to help themselves, to communicate with doctors and to support other groups of people. This mentionable use of internet, as described by Hardey (2001), empowers the individuals to change the communication between patients and doctors, which in term promises to deliver better and more efficient healthcare (Bergmo et al., 2005). It can also be said that e-mediated communication has the chance to increase the level of trust between
doctors and patients, making the process more tailored to the individual’s needs by also providing anonymity.

Neuhauser et al. (2003) mention that e-health communication can also help eliminate the limitations of traditional face-to-face communication, by providing 24-hour availability and increasing the participation of users with various social lives and circumstances. Thus, allowing patients behaviour to change to discuss personal problems in order to make rational decisions. The effective communication style will also increase the individual’s understanding of possible health risks and help them find support (National Cancer Institute, 1989).

Problem
The constant changes in our lifestyles are accompanied by various types of health problems, thereby resulting in higher demand for better healthcare. The European countries have found that the solution to the problem is e-health (Gartner, 2009; Stroetman et al, 2011), which is comprised of electronic applications, electronic health records, distant monitoring and online communication between carers and patients (Rizo et al., 2005) The solution to the problem comes partly from empowering patients and giving them the ability to self-manage their own health conditions, and increasing the speed of healthcare delivery by eliminating the need of face-to-face meetings (Alpay et al., 2010). The European commission supported this plan in 2012 with the goal to improve healthcare and benefit the patients (European Comission, 2012).

Although e-health has promising benefits for the population and has been used among the population in various cases, the effects and results are still not consistent (Ekeland et al., 2010; Bolton et al., 2011). However, there is a part of the population which has the highest chance of benfitting from implementing and using e-health systems- people with various chronic diseases and disabilities. Being able to self-manage their own conditions, people with chronic diseases and disparities can play a bigger role in preventing future health problems. Thereby, a research the use of e-health is important.

Nowadays, the interest in e-health is growing but is use is disproportionate (Beenkens,2011), which raises the requirements to promote and increase the use of e-health. Currently, there is no thorough research on what patients know about e-health, especially those with chronic diseases and disparities, and what attitude they might have for its use. More research is needed in order to understand the level of knowledge and interest of patients with chronic diseases and disparities, to find out if and how they use e-health applications to support their
wellbeing. Such and insight into the problem, will therefore be able to also understand what those applications currently offer to patients, and what the patients actually need.

Many people with disabilities do not have proper access to healthcare, and disability-related services, which are required for their wellbeing. Despite that, there is not much published information on how healthcare can be made accessible to meet the needs of people with disabilities. However, attitudes towards disabilities have changed and now there are more medical solutions which try to bring healthcare to people who are disabled by their bodies or by their environment.

Overview of diabetes

Humans are very complex beings in their nature and as such, our functions are made possible by very intricate organs, such as the pancreas. The pancreas is a gland, which is both endocrine and exocrine (Braun and Anderson, 2007). One of its functions is to produce insulin, which transfers glucose to the cells where it is converted into energy, and it also helps facilitate the synthesis of proteins.

When the pancreas loses its ability to produce insulin, or when the insulin cannot be used effectively in the body, the amount of glucose in the blood raises significantly. Thus, the inability to regulate the amount of glucose in the blood is determined as diabetes (Braun and Anderson, 2007).

According to science there are several forms of diabetes (Bellenir, 2008; Holt, 2009; Holt et al, 2010; Joslin et al, 2005; Krentz, 1996): type 1, type 2 and gestational diabetes. Diabetes of the type 1 which is also known as insulin dependent (Bellini, 2008; Holt, 2009; Holt et al, 2010; Joslin et al, 2005; Krentz, 1996) occurs during childhood. Type 2 diabetes is known as insulin non-dependent is the most common form of diabetes in the world. The third form of diabetes, which is gestational diabetes occurs rarely and only in pregnant women.

What exactly causes diabetes has not been well understood by modern science. However, according to Bellenir (2008) there are some genetic factors which can relate to diabetes. Type 1 diabetes is an autoimmune disease in which there is no insulin secretion in the pancreas (bellenir, 2008). On the other hand, type 2 diabetes creates resistance to insulin in the human body (Bellenir, 2008).

As already mentioned, it is not very well understood what causes diabetes, however, some of the risk factors associated with the disease include but are not limited to: genetic; overweight;
lack of physical activity. Many studies have tried to examine other environmental factors which can cause diabetes and have found that factors such as vitamin deficiency, viruses, stress, smoking can also support the development of diabetes across humans (Holt, 2010).

Health problems associated with diabetes

People who are diagnosed with diabetes can experience many chronic and acute health disorders (Bellneir, 2008; Holt, 2009; Holt et al, 2010; Joslin et al, 2005; Krentz, 1996). Some of the acute complications caused by diabetes are ketoacidosis and hypoglycemia. On the other side of the spectrum, the chronic conditions caused by diabetes are neuropathy, micro and macro vascular complications (Bellneir, 2008; Holt, 2009; Holt et al, 2010; Joslin et al, 2005; Krentz, 1996).

Neuropathy can cause foot ulcers and can in some cases lead to limb amputations, and micro and macro vascular problems include kidney problems, blindness, heart diseases.

Healthcare promotion

Healthcare is the “state of physical, mental, and social well-being and not merely the absence of disease or infirmity” (WHO Constitution, 1948, p. 1). There are numerous factors which affect the health of people with disabilities such as environment, health care services and the individual’s health problems (WHO, 2008; AIH, 2010). Also, the overall well-being of disabled people is affected by the inability to access health services, which leaves their health needs unmet (Beatty et al., 2003; Bowers et al., 2003; VanLeit et al., 2007; Gulley et al., 2008), thus people with disabilities have thinner margin of health (Dejong, 2002; Field, 2007).

Healthcare needs exist across the spectrum of the population, but there is a misunderstanding that people with disabilities do not need the same access to healthcare (Department of Health and Community Services, 2000). Healthcare systems are not designed to meet the specific needs of people with disabilities and many of those individuals, experience further problems. There are studies which present this exact problem for people with various disabilities such as stroke (Rimmer et al., 2008), multiple sclerosis (Becker, 2004), intellectual disparities and mental health problems (Disability Rights Commission, 2006).

Many people with disabilities do not receive health care because they encounter barriers to access those services (Bowers, 2003; Drainoni, 2006; McColl. 2008). The primary barrier is the physical access, and an increasing trend is the decreasing satisfaction of the healthcare
services provided to people with disabilities (Loeb, 2006). A way for solving such problems is to gain input from those people (Drainoni, 2006), who can contribute to the design of healthcare systems (Nilsen, 2003). Thus, the technical challenges of the users can be understood (Nilsen, 2003; Bedfordshire Community Health Services, w009) and the performance of healthcare improved (Dejong, 2002; Drainoni, 2006).

**Purpose**

Information and communication technologies have managed to improve the delivery of healthcare and have provided individuals with the ability to self-manage their own health (Borde, 2010). Some technologies show to have limited effect on health provision, compared to others, which have direct effect on improving healthcare for the individual users (Gagnon, 2009), such as: electronic health records (Crosson, 2005), telemedicine (Rowe, 2008; Taylor, 2009), consumer health informatics (Murray, 2005; Lorig, 2006). Thus, the purpose of this thesis is to study the level of understanding of e-health applications among users with diabetes in Bulgaria, to find out how they use those applications, and to provide knowledge on what m-health applications provide to people with diabetes, and what they actually need. In order for the purpose of this thesis to be achieved, the author chose to study four specific research questions.

**Research Questions**

For the specific needs of the research topic, the author broke down the purpose into four research questions, which can be answered with the data collection. And provide the necessary data to fill the knowledge gap in the current field of research.

- Q1. What mobile apps exist for self-managing diabetes?
- Q2. What is the level of acceptance and diffusion of e-health technologies among people with diabetes?
- Q3. How do people with diabetes use those technologies?
- Q4. What do people with diabetes require from those technologies?

**Delimitations**

As it comes to the research itself, it was focused only on diabetes. Although this does not serve as a limiting factor, the fact that mhealth services for diabetes is considered as
innovation in healthcare globally, the limited search only with the English language posed as a limitation. This impediment prevented the inclusion of more articles in the thesis which possibly made it difficult to develop a better literature review.

In this research, the author used the keywords mobile, diabetes, eHealth and mhealth, self-management in order to find the appropriate literature and mobile applications which were used to develop the topic and were limited to the field of study. Thus, there could have been important keywords which might have been excluded from the research, which could have also focused on mhealth.

Another critical delimitation that needs to be pointed out, is that even if the study focuses on a very specific population, it gives very general data which may not be relevant for other user groups. This arises from the fact that nowadays the health systems are built based on the needs of the local society. This points the fact that each system has its own unique sets of qualities such as infrastructure, users, level of development and expandability. Therefore, more studies on the varieties of populations are needed in order to complete the purpose of expanding and improving mhealth systems.

Although the research produces findings on the use of mhealth in the specified region, the region itself poses a great limitation towards the study of mhealth technologies. In order to increase the validity of the current findings this research needs to be expanded upon. The research should try to capture data from more respondents, not only users but also healthcare providers. Such a study can possibly generate enough data to validate the promotion of mhealth systems in the region.

It is important to mention that a deep and thorough research will always focus on many research objectives in order to be able to provide sufficient information on the specific topic. As already said, the research focuses only on a small part of those who adopt mhealth systems to monitor their health. Moreover, the study did not measure the factors which influence the use of mhealth applications to support health among diabetics. Although they might vary from belief in the outcome, doctors etc., this would have required to dwell deeper in order to measure health behaviour outcomes, such as the level of glucose in the blood, cost of use mhealth versus ordinary treatment, and healthcare trust. Therefore, in some reader’s eyes, the study might be incomplete.
Definitions

**Chronic**- “Chronic conditions are not passed from person to person. They are of long duration and generally slow progression. The four main types are cardiovascular diseases (like heart attacks and stroke), cancers, chronic respiratory diseases (such as chronic obstructed pulmonary disease and asthma) and diabetes.” (Mendis, S., World Health Organization, Global Status Report 2014)

**Consumer health informatics** - “is the branch of medical informatics that analyses consumers' needs for information; studies and implements methods of making information accessible to consumers; and models and integrates consumers' preferences into medical information systems.”. (Eysenbach, G.,2000)

**Diabetes** – “Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels”. (American Diabetes Association, Diabetes Care 2004)

**Disability** – “Disabilities is an umbrella term, covering impairments, activity limitations, and participation restrictions. An impairment is a problem in body function or structure; an activity limitation is a difficulty encountered by an individual in executing a task or action; while a participation restriction is a problem experienced by an individual in involvement in life situations”. (WHO, World Report on Disability 2011)

**Electronic patient record** – “Information about a patient health treatment electronically produced, stored and accessed within a healthcare institution”. (Manuela, M. Miranda, M.,2013)

**Etherapy**- “Internet based distance therapy used to expand clinical services to outlying people. Also called online therapy”. (Nugent, Pam M.S., 2013)

**Hypoglycemia** – “Hypoglycemia can be defined as the occurrence of a wide variety of symptoms in association with a plasma glucose concentration of 50 mg per dl or less”. (Field JB ,1989)

**Ketoacidosis** – “Diabetic ketoacidosis (DKA) is an extreme metabolic state caused by insulin deficiency. The breakdown of fatty acids (lipolysis) produces ketone bodies (ketogenesis),
which are acidic. Acidosis occurs when ketone levels exceed the body’s buffering capacity”. (Misra, S; Oliver, NS 2015)

**Neuropathy**- “neuropathy is characterized by diffuse damage to the peripheral nerve fibres. The commonest cause of peripheral neuropathy is diabetes, and 30–90% of patients with diabetes have peripheral neuropathy. Diabetic sensorimotor polyneuropathy (DSPN), the most common type of diabetic neuropathy, is associated with an impaired quality of life, significant morbidity and increased healthcare costs.” (Javed, S., Petropoulos, I. N., Alam, U., Malik, R. A. 2015)

**E-health**- “An emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology”. (Eysenbach, G., 2001)

**Information Communication technologies** “ICT incorporates electronic technologies and techniques used to manage information and knowledge, including information-handling tools used to produce, store, process, distribute and exchange information. Benefits of ICT can be achieved directly, through improved healthcare provision and disease prevention, or indirectly, through improved social infrastructure, economic growth, or other broader determinants of population health.”. (Joshi et al., 2013)

**Remote health monitoring devices**- “Remote patient monitoring (RPM) has enhanced clinicians' ability to monitor and manage patients in nontraditional healthcare settings. RPM uses digital technologies to collect health data from individuals in one location, such as a patient's home, and electronically transmit the information to healthcare providers in a different location for assessment and recommendations. More specifically, noninvasive technologies are now commonly being integrated into disease management strategies to provide additional patient information, with the goal of improving healthcare decision-making.”. (Vegesna et al., 2017)

**Telemedicine** – “The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries,
2 Literature Review

It is obvious that with the advancements in technology and connectedness, the use of mobile devices is growing. Moreover, technological advancements result in the development of new requirements for healthcare. The research shows that some of those requirements are applications for diabetes self-management (Lim 2011; Lyles 2011; Liang 2011). And although such applications are in use already, it is not well known what their effects on health care are, and if they meet clinical guidelines.

Researchers still have very different opinions on whether application for self-managing diabetes actually provide tangible benefits, and if so are they really that great. For example, Farmer (2005) concluded that there are distinctive benefits from monitoring blood glucose levels. Also, Faridi (2008) found no improvement in patients when comparing the use of mobile applications versus a traditional therapy. Seto (2009), also proved that there are no benefits for the patients from simply monitoring the blood glucose levels. He went further to mention that in order for the application to have effect, it should be able to communicate with healthcare providers.

Research Criteria

The following literature review aims to understand the current use of eHealth, i.e. the use of mobile and wearable interconnected technologies in healthcare and patient’s decision making. A probing of the literature was carried with the use of predetermined keywords, in order to identify relevant information on the subject of study. The literature selected dates from the year 2005 with the idea to capture more detailed data from the initial use of eHealth technologies up until today’s more mature use of mobile devices and supporting applications.

Search strategy

All articles which were found were reached through search into Google Scholar, and were only limited to the use of English language. The keywords used for the finding were: diabetes self-management AND information technology AND ehealth OR mhealth OR telemedicine AND disease AND management AND monitoring AND health AND support AND
prevention AND communication AND education. Moreover, the search for articles was
categorized based on title and abstract fields, in order to eliminate unnecessary information.

**Criteria for exclusion**

The author used the following criteria for excluding articles: (1) the articles selected were
only from the previously specified timeframe; (2) articles in foreign language were removed
from the search; (3) only peer reviewed publications were selected; (4) articles which were
unavailable were not chosen.

**Results**

The initial search into Google Scholar provided 340 articles. When the title and abstract were
reviewed, the total number of articles which were identified to contribute to the topic 105.

According to the sample, all articles which were extracted from the initial search were
grouped to together to form clusters of the following topics: (1) disease management; (2)
disease monitoring; (3) supporting health; (4) disease prevention; (5) communication; (6)
education.

**Disease Management/ Table 1**

The literature was able to provide data on disease management for diabetes (Curioso et al.,
2009; Dick et al., 2011; Kim et al., 2006; Kollman et al., 2007; Logan et al., 2007; Quin et al.,
2009; Quinn et al., 2011) relative to the patient’s visit to doctors (Geraghty et al., 2008; Lester
et al., 2009; Mbuagbaw et al., 2011; Milne et al., 2006; Strandbygaard et al., 2010) and their
use of the medications prescribed (Curioso et al., 2009; Curioso et al., 2007; Montes et al.,
2012; Vervloet et al., 2012; Vervloet et al., 2011). The actual process of disease management
is explained as the use of communication technologies such as messages and mobile apps
which allowed the patients to self-manage their diseases by coordinating with therapists. Both
in developed and in developing countries such as United States (Dick et al., 2011; Quinn et
al., 2009; Holtz et al., 2009; Foreman et al., 2012) United Kingdom (Milne et al., 2006;
Pinnock et al., 2007; Ryan et al., 2005) and Peru (Curioso et al., 2007; Curioso et al., 2009)
and Kenya (Lester et al., 2009; Kelly et al., 2011), healthcare providers have resorted to
interventions based on mobile devices which communicated by sending reminders to patients
for medication and exam adherence. For example, short messages were sent to patients with
type 2 diabetes to remind them to take their insulin alongside with the appropriate dosage
(Vervloet et al., 2011; 2012).
Moreover, the use of mobile applications helped patients with diabetes to send real time blood glucose levels with a mobile glucometer (Quinn et al., 2008; 2009; 2011) and also to receive immediate feedback from physicians regarding immediate actions regarding lifestyle. Such applications were deemed by patients as useful (Montes et al., 2012), and proved to increase adherence in the long term since they provide ease of use and cost efficiency (Geraghty et al., 2008).

In all of the instances mentioned in literature, mobile technologies were used predominantly as messaging tools, mostly for adherence to medicines. They were connected to electronic health records which were responsible for sending the automated messages, and also for storing incoming data from glucose monitoring devices.

**Disease Monitoring/ Table 2**

Disease monitoring is widely used to calculate the spread of particular disease in a specified region in order to establish its progression among individuals (Flahault et al., 2006; Rivett et al., 2008; Kim et al., 2009; Horst et al., 2010; Kelly et al., 2010). In those instances, monitoring proved effective in tracking incidence, prevalence and served as the base for creating statistical diagrams (Gosselin et al., 2005). Which in terms help to understand target areas, develop appropriate response and future costs of healthcare (Kelly et al., 2013).

Interventions based on mobile technology were tailored mostly at sending food intakes for analysis to dieticians (Wang et al., 2006). This simple yet important use benefited patients by increasing the quality of the data which physicians were able to collect so far (Pierre et al., 2009; Ganesan et al., 2011). Literature also shows that those systems provide significant increase in data integrity (Galliher et al., 2008) which resulted in reduction in processing time of patient’s information and reduced errors (Blaya et al., 2008; Barnabe-Ortiz et al., 2008; Jian et al., 2012).

Many countries such as Sweden, Norway (Dale et al., 2007; Heiberg et al., 2007), USA (Fowles et al., 2008; Galliher et al., 2008; Siracuse MV, Sowell JG, 2008; Magee et al., 2011), UK (Tasker et al., 2007; Whitford et al., 2012), China (Yang C., Yang J., Gong P., 2009) and Peru (Barnabe-Ortiz et al., 2008; Blaya et al., 2009), have investigated mobile technologies as means for monitoring. They reported using the available patient data to report general health of the public and for tracking diseases which are communicable. Also, such data was used to pass on information to patients through mobile devices to deliver laboratory results and to collect situational data (Magee et al., 2011).
Health support systems using mobile technologies are various. They range from mobile phone-based applications, text messages, voice communication and many more. Mobile phone apps are the invention which provides people with diabetes with the best solution to self-manage their health. One such form of self support is the use of mobile apps to create a food support plan by allowing patients to self manage their diet (Arsand et al., 2008). Many such apps are designed also to support other managing processes (Mohan et al., 2008) such as weight loss (Patrick et al., 2009).

The use of text messaging communication technologies is also widely spread in healthcare settings, because they allow to be integrated with electronic health records which enable data to be captured among patients in a faster rate (Altuwaijri et al., 2012). Additionally, text messaging systems have been utilized in healthcare settings, where self support models have been tailored for specifically insulin therapy in patients with type 1 diabetes (Franklin et al., 2006). This technology has also successfully promoted the increased share in information regarding blood glucose monitoring (Hanauer et al., 2009), medication adherence (Mao, Zhanh, Zhai, 2008) and education among diabetics who belong to the younger age group (Waller et al., 2006).

Moreover, handheld electronic devices have allowed the development of mobile healthcare management systems (Chau S., Turner, 2006), where data is collected and stored into a system by the public (Yu et al., 2008). Thus, the data which is collected and stored in the system serves the purpose of displaying patient information in clinical setting (Brock TP., Smith SR., 2007), accessing electronic health records (Choi et al., 2006) and, for example, to monitor dieting among individuals with type 2 diabetes (Sevick et al., 2008).

The use of mobile phone applications proved to have a positive effect on improving the overall health self-management among individuals with type 1 diabetes, and also proved to have lowered healthcare quit rate (Free et al., 2009). Since such technologies are inherently easy to use and do not provide any obstructions from use in everyday settings, patients with diabetes reported that it provided them with a more efficient way to adhere to their insulin medication and that it also helped improve their metabolic control (Benhamou et al., 2007).

Handheld mobile technologies which were used to support healthcare, resulted in less errors during data gathering (Blaya et al., 2006). Moreover, they provide an ever-easier way to communicate such data (Choi, Yoo, & Park, 2006), and thus being able to help people with
type 2 diabetes to manage their imparity (Sevick et al., 2008) for a fraction of the regular cost of physically going to the hospital (Yu et al., 2009).

Mobile technologies have been used in a wide range of countries for sharing disease related information (Gao et al., 2008) and for estimating health needs among populations in rural areas (Schuurman et al., 2011), thus assisting in understanding environmental factors and health effects over the population (Choi et al., 2006).

**Disease prevention/ Table 4**

Many developed countries and developing countries have been and are currently testing mobile communication technologies which support patients’ wellbeing. Most of the interventions associated with mobile and phone-based apps have been mostly used for transmission of health status (Bielli et al., 2005) by patients and for health data review by physicians (Caroll et al., 2007).

In such cases the literature review established that health interventions with mobile technologies were mostly carried out by short messages as remainders. In other cases, patients sent data on exercise and eating behavior and in return they received feedback from a doctor (de Niet et al., 2012). Also, it is a common practice for patients to send blood pressure data to a doctor and receive tailored information on whether blood pressure was anomalous (Engineers IOEAE, 2008). Another beneficial use for messaging systems in clinical environments proved to be education. In other words, text messages provided quick and efficient way to inform and educate diabetics on their state of health and future interventions (Kim H.S., 2007; Kim H.S., 2007). Moreover, they were used to monitor food intake levels of patients (Schembre et al., 2011), send eating guidelines and physical activity (Gerber et al., 2009).

The frequent use of mobile communication technologies in clinical environments lead to high number of benefits such as improved healthcare attendance (Leong et al., 2006; Chen et al., 2008). Also, a benefit was seen in monitoring the glucose levels in patients with type 2 diabetes (Kim, 2007; 2007). It can be stated that those simple technologies help reduce the amount of missed appointments at hospitals (Perry, 2011; Prasad & Anand, 2012), and offer low-cost way to reduce the amount of time necessary to diagnose a patient (Menon-Johansson et al., 2006).
It should be mentioned that compared to a phone call, a message has lower cost and higher effectiveness (Leong et al., 2006; Koshy et al., 2008). Thus, the amount of expenses which hospitals run through constantly, is reduced by a significant margin by utilizing resources in a more efficient way (Scanaill et al., 2006). Another important aspect of using mobile technologies for patient-health provider communication is the ability of healthcare institutions to predict geographical locations for deployment of telemedicine services (Bramanti et al., 2010).

More uses of telemedicine include the observation of the characteristics of various residential locations to detect changes in blood pressure (Li et al., 2009). The development of maps with the geographic spread of injuries and demographic patterns (Odero et al., 2007), and to understand patterns of obesity in geographic regions (Pauliou & Elliott, 2009). The use of health information systems helped to understand the sociodemographic influence on physical activity (Burton et al., 2009). Moreover, geographic data proved that relationship exists between risk factors, healthcare providers, transport (Ghetian et al., 2008), and diabetes risk and diabetes screening rates in various locations (Kruger et al., 2008). Also, geographical mapping and data analysis revealed regions with lower and higher obesity risk in Canada, and several states in America (Pauliou & Elliott, 2009).

Communication/ Table 5

Interventions which utilized mobile technologies were various. Some interventions were designed to collect data from patients who used portable devices, which recorded asthma symptoms (Cleland et al., 2007) and to store them in an electronic health record. Others utilized video consulting of patients with amputations and communication between physicians themselves (Hsieh et al., 2005). A common practice was the transmission of data from ambulances to cardiologists (Hsieh et al, 2010). As previously described. Messages are simple and efficient way for communication between patients and physicians. They were used to send and receive exercise data and diet information for patients with obesity (Joo & Kim, 2007).

The use of mobile health technologies benefits society in greater way. They enable the communication with doctors and healthcare providers and also eliminate the need for face-to-face meetings Cleland et al., 2007)). Thus, doctors use more time to create rapport with patients instead of working with various documentation during consultations (Buck et al., 2005), thus providing more accurate diagnosing, minimizing costs, which leads to better
treatment (Kuiper R., 2008). And on the other hand, this innovative technology served as the base for becoming educational tool (Curioso et al., 2008), and improved the management of chronic diseases outside of the healthcare environment (Fischer et al., 2012).

**Education/ Table 6**

In healthcare environments, mobile technologies serve the purpose of improving education among students in healthcare (Farell K.J., Rose L., 2008). Moreover, they allow students to determine the changes of health in patients, and to provide them with data for the immediate health intervention which are required in any given case (Stayer et al., 2010). Another predominant use of mobile technologies in educational environments among students, is mobile applications. Applications are typically used by students to give them access to drug references during practical exercises (Grasso et al., 2006).

Using mobile technologies in the previously explained cases, have proven to lead to higher self-efficacy (Goldsworthy et al., 2006). This is the result, because such technologies are very easy to use and increase their learning potential (Farell & Rose, 2008).

**Review on current applications for self-managing diabetes**

The following review will provide a short analysis of the features of mobile apps. It is also going to answer the very first research question (*Q1. What mobile apps exist for self-managing diabetes?*) in this thesis by comparing evidence-based information to show current applications for self-managing diabetes. The idea behind this approach is to show the most available functionalities of the current mobile applications and explain them against evidence-based research.

**Methods**

The task set for this app review was to find some of the most-functional diabetes self-management mobile applications in the Apple app store and to find proof of their functionality in research. The app store was very good in showing which application were more mature and with higher use and having apps with already good and established functionality made it easier to compare to evidence-based research. The apple app store was chosen due to the immediately available access of the researcher to its database and because it was the first commercially available market for mobile mHealth apps. More application markets such as Google Play store were not chosen for this research due to the very limited time period which could be allocated for work.
The search in the Apple app store was conducted by using the search term “diabetes”. Then, the author selected peer-reviewed articles in Google Scholar using the search terms “mobile AND smartphone AND diabetes”. Then, the author selected peer-reviewed articles in Google Scholar using the search terms “mobile AND smartphone AND diabetes”. The title, abstract and text were selected based on the criteria:

- Support for monitoring blood glucose levels
- Patients as the end user
- The ability of the application to promote self-managing by providing more functions

Criteria

The selection criteria were targeted to applications which had relevant connection to diabetes, and which were already popular in use. Popularity meant that any limitations to the use of those applications had already been fixed and the focus on the end user was clear. The applications were chosen to represent medical use and health and lifestyle use. Also, application which did not use English as the primary language was excluded from the research.

Application assessment

During the review, the author noticed that the applications possess the following features: (1) self-monitoring; (2) blood glucose; (3) activity; (4) diet; (5) learning; (6) personal health records. All of those features which seem very isolated from one another can be used to work in a single diabetes self-management application. For example, when the user records one or more values in the application, the application itself can show how those values correspond to the rest of the features inside the application. Such an advanced software, after testing can possibly provide grounding results for the theory that diabetes self-management applications really do provide measurable health benefits.

Table 9. Shows the applications which were chosen for this literature review. They were reviewed and based on their functionality the author was able to determine the current trend in the development of applications for diabetes self-management.
Results

*Applications which support decision-making*

Decision-supporting applications are often used to provide feedback on issues such as the levels of insulin, food intake and physical activities. In the research, only some of the articles explained the form of decision support (Preuveneer and Berbers, 2008; Quinn, 2011). An application which is dedicated to enabling decision-making is usually stored on the device of the patients. Based on the user’s activity with the application, it is able to calculate data and provide suggestion on health-related actions. In some cases, such applications are even connected to Electronic Health records, which allows a physician to review the data and provide feedback. One such application as explained by Preuveneer (2008). There, the patients input data on physical activities and the blood glucose levels, and the app calculates the proper insulin dosage for the patient. However, most reviewed applications only provide insulin dosage suggestions, such as RapidCalc Diabetes manager (Gilport Enterprises), rather than including more aspects of the physical lifestyle of the patients.

*Applications as communication channels*

Due to the ability of mobile applications to store data means that, the patients take advantage of being able to send the data to doctors in order to receive quality feedback on their health. Moreover, the patients can receive instant response from the doctors, and can also set up automated alerts when necessary (Ciemins et al., 2010). During the review of the mobile applications, it was noted that most of them allowed the exchange of data, such as Your Diabetes Guardian.

*Applications Integrated with Electronic Health Record*

The electronic health record is an electronic data log which stores patient information on the health provider’s medical server. Thus, the stored information allows for better and more timely health management. One such readily available application is Microsoft’s HealthVault, which serves as a personal health record. Moreover, several of the reviewed articles on the topic, provide extensive information on electronic health records which connect patients to doctors (Preuveneer, 2008; Farmer et al., 2005; Harris et al., 2010; Lyles et al., 2011; Kollman et al., 2007), which serve as a proof of how useful this is for the patients.
Learning

Education about diabetes is by far the most important requirement for patients in order to have healthy life. By improving their knowledge of what diabetes is and what consequences it brings for health, the patients can self-manage the disease more efficiently, minimizing the risks of further complications (Funnell et al., 2012). Research has done a lot to provide proof that knowledge improves care of one’s health (Norris et al., 2002). There are some applications which provide education about diabetes (Diabetes App Lite; dLife), however, due to the individual impact that disease has upon various patients, it is necessary such educational applications to be tailored to the individual needs. Only a single application provided this (Track3, Coheso). In the literature which was selected for this review, there were several articles which studied the individual component (Mohan et al., 2008; Quinn et al., 2008, 2011). Personalization of the treatment is of extreme importance. An application can be tailored around the patient’s condition and lifestyle. The one application which was found for this review is of Quinn (2011). It allows the patients to enter personal data and receive information for their specific condition.

Evaluation

Some of the research found in the articles shows that mobile application which are intended for patients to self-manage diabetes, manage to achieve positive outcomes when it comes to managing health, such as achieving better health through tracking food intake (Arsand, 2010; Ma, 2006). This is a partial indication that mobile applications can serve as tools to manage one’s health. Moreover, mobile applications enable self-efficacy, which in terms supports better blood glucose levels, physical activity and more (Arsand, 2010). Also, it is important to mention the fact that, the increasing connection between smartphone devices and cloud computing services, will allow the patients to access better analytic capabilities, which will make the applications provide better feedback and information which is more tailored to the individual needs of the patient (Nikosi and Mekuria, 2010).

In conclusion, it can be argued that some of the applications really do provide value for diabetes self-management. However, there remains the need to understand that diabetes self-management applications cannot fit all users who suffer from diabetes, due to the fact that the disease itself varies from patient to patient in terms of its complications and effects on the human body. Moreover, such applications can only be used with high success rates if they are targeted to the user’s specific needs (LeRouge & Wickramasinghe, 2013).
3 Theoretical Framework

IDT and TAM

According to (Lau and Woods, 2008) studies on how users perceive and understand the use of IT/IS systems are necessary to understand their acceptance and use. There are also previous researches, which focused on finding what constitutes a decision to adopt a technology based on the TAM model (Davis, Bagozzi, Warshaw, 1989; Taylor and Todd, 1995; Venkatesh & Davis, 2000).

This research will use TAM variables combined with innovation diffusion theory to produce knowledge on technology acceptance. Therefore, the factors of relative advantage, compatibility, complexity, trialability and observability will be used to determine perceived usefulness, perceived ease of use and behavior intention to use a technology. The author believes that this approach to theory can help to understand e-health technology acceptance.

The TAM model has been used for many technology acceptance studies and continues to contribute to understanding how users accept the use of information systems and information technology (Taylor & Todd, 1995; Venkatesh & Davis, 2000), and is also used to predict the level of technology acceptance of the users.

In this research, the author has defined perceived usefulness as the level of healthcare improvement due to the use of a system, and perceived ease of use has been defined as the perception of the ease to adopt the system. Also based on systems research (Arbaugh & Duray, 2002; Pituch & Lee, 2006), the author assumes that if the users perceive an e-health system as useful, this will influence positively the acceptance of e-health systems and future adoption. Moreover, Ajzen and Fishbein, (1980), determine that technology acceptance is influenced by behavioral intention to use the technology. Thus, the level of acceptance of technology is determined by the user’s intention.

The TAM is one of the best models to explain the level of acceptance of technologies, however the model cannot be used to analyze all cases of technology acceptance. Thus, there are many studies on the TAM model, which suggest that the model can be combined with other theories, such as IDT, and to increase its potential to analyze the changes in IS/IT (Carter & Be’langer, 2005; Legris, Ingham & Colerette, 2003).

Researchers state that the TAM and IDT theories have similar constructs which can be used to complement each other in the study of IS/IT, and that the constructs in the TAM are subset of
innovation characteristics, which strengthens the idea that the combination of the two theories can produce a stronger model (Wu & Wang, 2005; Chen, Gillenson & Sherell, 2002).

Technology Acceptance Model (TAM)
The technology acceptance model (TAM) was developed to study the specific human-computer interactions (Davis et al., 1989). According to the TAM model, technology acceptance is determined by PU and PEU, which dictate the user’s intentions to use information technology. Perceived Usefulness (PU), is the individuals believe of whether information technology would increase the user’s performance in a specified context (Davis et al., 1989). The second, determinant, Perceived Ease of Use (PEU), is the individual’s belief of whether using such technology would be effortless (Davis et al., 1989).

Numerous researches on the TAM model have been successfully conducted, proving that the model provides accurate measurement of the user’s intentions behind accepting IT/IS technologies (Igbaria, Zinatelli, Cragg and Cavaye, 1997; Venkatesh and Davis, 200; Horton, Buck, Waterson and Clegg, 2001). In addition, the TAM explains what determines the acceptance of technology by understanding the behavior of the end user (Davis et al., 1989).

Innovation Diffusion Theory (IDT)
Innovation Diffusion Theory has been used in many social spheres such as sociology, marketing, and information technology (Rogers, 1995; Karahanna, et al. 1999; Agarwal, Sambamurty and Stair, 2000). According to Rogers, an innovation is “an idea, practice, or object that is perceived as new by an individual or another unit of adoption” (Rogers, 1995, p.11). According to Rogers again, diffusion is “the process by which an innovation is communicated through certain channels over time among the members of a social system” (Rogers, 1995, p.5). Thus, IDT explains that, innovations are adopted or rejected by the users based on their attitude towards the innovation.

The core of IDT is comprised of five innovation characteristics: relative advantage, compatibility, complexity, trialability and observability. Relative advantage represents the degree to which an innovation is believed to be better than the one it replaces, which is considered to be main motivator for adopting an innovation. Compatibility refers to the degree to which the innovation is consistent with the current norms, practices, values and needs. Complexity on the other hand, characterizes the difficulty of understanding and using the innovation. Trialability of an innovation decides whether it can be easily tested. Such a characteristic is important for forming the decision-making process of adopting an innovation.
And last, is observability, which determines whether the benefit and results of the innovation are visible to other potential users. Those five main characteristics of an innovation form the base on which the users decide whether or not they should adopt an innovation.

Both the IDT and TAM do not have many connecting points; however, they have several important ones. First, the characteristic of relative advantage in IDT resembles that of PU in TAM theory, and both the complexity characteristic in IDT and PEU in TAM are similar (Moore and Benbasat, 1991). Moreover, both IDT and TAM determine that the level of innovation adoption is based on how difficult to use and understand the innovation is (Rogers, 1995; Davis et al., 1989).

Many studies have used the combination of TAM and IDT to research the level of technology acceptance (Hardgrave, Davis and Reimenschneider, 2003; Wu and Wang, 2005; Chang and Tung, 2008), thus in this thesis the use of TAM in combination with IDT and their constructs (compatibility, complexity, relative advantage, trialability, observability, PU and PEU) is aimed at increasing the reliability of the research on innovation diffusion

4 Methods

Various literature explores the use of questionnaires in research methods, and it is also a very popular tool for data collection. Oppenheim (2000) argues that questionnaires are hard to develop. This is due to the fact that he questionnaire must have a way to collect very precise data. Also, before using a questionnaire, all possible tools for data collection must be checked in order to understand what best serves the research in mind. This is, because questionnaires are only usable for collecting descriptive and explanatory research, and in cases where the researcher is not likely to have a great amount of contact with respondents (Robson 2002). Thus, questionnaires are easier to implement than other research methods (Jankowicz 2005).

The choice of the questionnaire in this research was influenced by several factors. First it was the characteristics of the respondents. The respondents were of various ages and lived in different locations across the country. Which ultimately made contact a lot difficult. Moreover, a specific cultural characteristic, which hindered the use of other research methods was the fact that Bulgarians tend to show distrust when being asked to become involved with research such as a master thesis.

The second influencing factor was the size of the sample which was needed in order to produce data for the research. As with this particular thesis, a larger sample size was required
for the development of meaningful data in order to prove the underlying scientific theory. Thus, reaching tens of people for the purpose of performing interviews for example, was a task too hard to achieve. Nevertheless, it must be noted that the author was challenged to use other research methods because of availability of interviewees and people to assist with data entry.

Validity and testing

Internal validity is related to a questionnaire’s ability to measure the data required for the research, or in other words, to measure the reality. Cooper and Schindler (2008) refer to measuring validity as content validity and construct validity. Content validity is achieved through carefully defining each question in the questionnaire through the literature review. Construct validity, is associated with the extent to which the questions capture the constructs needed to answer the research. Or, construct validity captures attitudes and likes (Cooper and Schindler 2008).

Before using the questionnaire, it was tested with five diabetics to which the author had access to. The preliminary test served as a base to further refine the questions and to make sure that those who respond, would not have problems with understanding the questions. It is typical for researchers to tend to skip the testing phase due to time restrictions however, as Bell (2005;147) noted, putting a questionnaire through a trial phase is crucial for the reliability of the data which is to be collected.

This research was intended to gather information on the use of diabetes self-management mobile apps in a standardized manner. The instrument used for the survey, a questionnaire, aimed to provide information on the use and experience of mobile health apps for managing diabetes. The recent literature review which related to the outcomes of using self-management apps, and the theoretical framework for the research were used to create a range of items. The items were divided into two parts: (1) Items relating to general view of diabetes and mobile applications; (2) Items relating the IT knowledge, use and opinion of diabetes self-management apps.

The research was carried out in two stages. Stage 1 aimed to distribute the online questionnaire across individuals with diabetes in order to test whether the items in the survey were suitable for the target sample to comprehend, due to the fact that the country is not native to English. Stage 2 aimed to finalize the questionnaire and to correct its validity and reliability
Participants

The participants in the survey were men and women between the ages of 18 and over, living in Bulgaria and who had Internet access. To ensure items were appropriate for the questionnaire, they were administered across a range of individuals with diabetes. It is often suggested that tests require at least three times as many respondents as items (Kline, 2000). Therefore at least 90 respondents were required for this survey.

Sampling of respondents

Self-selection: Probability sampling is perhaps the most appropriate method for the purpose of studying a population. Nevertheless, it has rich history within research and with its solid theoretical background has been proven to be effective in numerous researches. However, probability sampling is not the only method used in research. Often, samples which require individuals with specific characteristics have been obtained by a method of non-probability sampling (McCarthy, 1958).

Non-probabilistic research methods have changed a lot with the development of internet and relevant technologies. Vast majority of the surveys now use non-probability sampling techniques, and as Brick (2014) has suggested, they are a better choice, if they match three criteria:

1. The cost of data collection has to be lower.
2. The estimates of the research do not need to be very precise.
3. Even if the data needs to be more accurate, non-probability sampling can be used when the target population is well-understood.

Data collection by the means of a survey is a complex, and time-consuming task. Due to this fact, numerous attempts have been made in order to reduce the cost and time for their development. Thus replacing the questionnaire with an electronic alternative cut processing time, cost and quality (Couper, 1998).

Since the objective of every survey is to collect data about a specific population, the population sample for the current research was targeted to be diabetics in Bulgaria, who had internet access. Because a web survey is always self-administered, the potential respondents only needed to fill a simple form. An invitation to participate was given to individuals with
diabetes through phone calls and Facebook, and in addition, the method of snowballing was used, so that the survey could reach the people with needed characteristics.

With such sampling methods questions are not asked face-to-face, and what differentiates form other methods is that samples are not constructed with probability sampling but by the act of self-selection by those who decide to take part in the research. Often such surveys are recognized as self-selection surveys.

The questionnaire

An online survey was created by using Google Forms. The participants were asked to access the online questionnaire and answer sets of questions about their general views and use of diabetes self-management applications. Those participants, who had not used diabetes self-management applications, were allowed to familiarize themselves with the software, use it and then come back to the questionnaire. The total length of time estimated for completing the questionnaire was 5-10 minutes.

Results

The final online survey was completed by 71 participants, 38 of which were female, 28 were male and seven were of non-specified gender. The introductory stage of the survey showed that most of the respondents were between the ages of 31 to 40 years old (28.2 %), and that the largest part of the population sample has been diabetic for five years (32.4%).

On the second section of the survey, which asks general questions about the participants’ experience with diabetes, the results show that from all of them (59.2%) have irregular visits with a doctor, however, 87.3 % of those who responded show to be well aware of what diabetes actually is, and that 39.4% manage their disease by using medication. An important question was created in this section in order to show the respondents IT knowledge, in order to show why people, use or do not use mobile apps.

The result of that points to the fact that the vast majority of the people (43.7%) have high knowledge of the use of mobile phones. Not surprising was the fact that due to the higher knowledge of the use of mobile phones, 100% of the participants responded positively that to the question if they were willing to try out diabetes self-management apps to see if it they show benefits.

The third and fourth sections of the survey which are the most important ones, because they try to find relationship to the theoretical framework behind the thesis. The results in this third
phase of the survey show that 93% of the respondents actually already use diabetes self-management applications, and that the majority of the people 65.2% use them for medication adherence purpose. Although this is only a general use of the software, 47% of the respondents tend to show high frequency of the use of the mobile applications, since they responded that the use the application daily. Regardless of those high numbers, only 36.6% of the people really believe that diabetes self-management applications really benefit them.

The results in relation to TAM and IDT

The fourth section of the survey tested the idea of the TAM and IDT models to find relationships for the use and acceptance of the technology. Both the IDT and TAM determine that the level of innovation adoption is determined entirely on how difficult to understand and use an innovation is. Moreover, the characteristics of relative advantage in IDT resemble the perceived usefulness in TAM, and the complexity characteristic in IDT is similar to perceived ease of use in TAM. Therefore, the factors of relative advantage and complexity, will be used to determine perceived usefulness, perceived ease of use and behavior intention to use a technology.

The fourth section of the survey questionnaire asked specific questions about the items of relative advantage and complexity in order to aggregate enough data for a better result. When asked if diabetes self-management applications provide any relative advantage over the traditional methods for managing the disease, 74.6% of the respondents answered positively. This result shows that the respondents benefit from using the applications. The second question, about complexity, shows quite similar result, 53.5% of the respondents stated that diabetes self-management apps are not complex to use.

By taking into consideration the above results, it can be said that 74.6% of relative advantage correspond to very high perceived usefulness on behalf of the respondents. However, a score of 53.5% shows that the people who took part in the survey exhibit high perceived ease of use of the mobile applications. This concludes that initially upon using diabetes self-management applications, the respondent’s exhibit high behavioral intention to do so and due to the fact that the applications are not defined as complex, they are suitable for constant use.

However, the above-mentioned descriptive statistics are cannot give definitive answer to whether there is a relationship between the constructs of relative advantage, complexity, perceived usefulness and perceived ease of use. The only method to produce such an answer is to use SPSS to statistically test for correlation in order to be able to provide proof of the
theoretical model proposed in the research. Since the theoretical model suggests that the constructs of relative advantage and complexity in IDT match the perceived usefulness and perceived ease of use in TAM, they were paired in the exact same way for testing in SPSS. The result of which can be seen in tables 7 and 8 taken from SPSS.

SPSS tested the validity of the descriptive statistics mentioned earlier by dividing the constructs into pairs. The first pair tested for a correlation of relative advantage to perceived usefulness, since the two constructs complement each other, and if one matches the other, the result shall serve as a proof of a theory. The result from the test shows a negative correlation of -0.12. This number shows that in the case of the research perceived usefulness might build a negative opinion on relevant advantage, but it does not define negative behavioral intention to use or adopt certain technology, since perceived usefulness only explains the beliefs of an individual of whether a technology is beneficial or not. And if a certain technology proves to provide better quality of life, the user will adopt it for wellbeing.

The second statistical test of complexity and perceived ease of use showed a positive correlation of 0.87 between the two constructs. Since perceived ease of use is determined as the required amount of effort needed to understand and use a technology, highly complex inventions will negatively affect the behavioral intention of the user to adopt a technology. Thus, if everything is constant, the user will use a method or technology which is the easiest. Thus, some diabetics may keep using handwritten diaries instead of complex mobile applications.

This result may not be considered as absolutely definitive. According to the survey, 93% of the respondents stated that the mobile applications can be easier to use if they were in a native language. Logically, it can be assumed that if the respondents used applications in a native language, then the level of adoption of diabetes self-management apps through the Bulgarian society could have been greater.

Conclusions

The information gathered from the survey and its analysis has been enough to answer the three research question that this thesis tried to explore:

- Q2. What is the level of acceptance and diffusion of e-health technologies among people with diabetes?
- Q3. How do they use those technologies?
• Q4. What do they require from those technologies?

Starting off with the first question, the data clearly showed that the level of acceptance and actual adoption of diabetes self-management applications in the Bulgarian society is relatively low, due to that people perceive the technology as of yet, difficult to incorporate in everyday settings. As mentioned earlier, a big factor for that is because the applications do not support native language.

As to the second research question, when asked how they use diabetes self-management applications for, 65.2% of the respondents chose to answer that they mostly use the applications for the purpose of medication adherence reminders. And the second highest result of 53% showed that they use the application for the purpose of healthy eating. The data shows that the use of diabetes self-management applications by people with diabetes is still very basic, however it must be take into account that diabetes self-management have yet to grow in popularity and function among users.

The third research question grounded in this thesis is also an important one. It is a well-known fact, that, the level of use and adoption of technologies is strongly based on the end user requirements. Thus, when a new system is developed, it is being distributed among beta testers in order to determine what is wrong and what needs to be added to the final product before its release.

In the survey conducted for the purpose of this thesis, it was discovered that the two most important requirements of the end user are support for native language, and increased application functionality. Or in other words, people with diabetes prefer that one application provides more than one function at a time. Exploring deeper into that insights and providing proper solutions, will lead to an increased adoption of the use of diabetes self-management applications.

5 Discussion

The perspectives for using eHealth technologies in our daily lives are great, and they are constantly being strengthened by the rapid development of the technology and its innovative use. As these changes continue to occur, patients will be provided with better ways of monitoring their health conditions and preventing such from happening. Because our lives have become more complicated and time more expensive, the ability to use devices and software for self-monitoring will greatly increase the quality and delivery of healthcare
Although the benefits of electronic healthcare have been widely understood, as Ekeland (2010) and Bolton (2011) mention, the results of their use are not consistent. Thus, as the focus of the thesis was to understand the use and diffusion of the technology among a small population in Bulgaria, the author also tried to find if there are positive effects of the use of such technology among the target sample, and to expand upon the provision of consistent results which are meant to serve as proof of the benefit of eHealth.

This study was conducted to gain insight into the level of knowledge and experience of people with diabetes with mobile health applications for diabetes self-management, and their attitude towards the use of such applications for daily healthcare. The results provided that people who suffer from diabetes are familiar with eHealth applications, however their use is relatively low. Those who took part in the survey showed that they have experience with eHealth applications and are positive about it.

The idea for this approach was generated during the time of performing the literature review, since some researchers such as Beenkens (2011) mention that the use of eHealth is disproportionate. Of course, no single research can provide full understanding of what society knows about eHealth–related technologies and whether or not they are actually being utilized in different parts of the world. However, by performing small probes in different parts of the population, researchers can provide enough knowledge to conclude whether or not the technology is as of yet beneficial, or it has to mature further. And the attempt of this thesis was to probe into the condition of people with diabetes in Bulgaria, because the state of development of innovative methods to monitor this disease in the region are unknown.

Filling this gap

The problem with the topic is the fact that the use of eHealth technologies in Bulgaria is not thoroughly studied and creates a gap in the scientific field. It is not known if the society is prepared to use the technology, or if the healthcare system can provide the necessary infrastructure to support eHealth. In order to move the field forward, it was of utmost important to create and perform a research that could serve as the base for the development of eHealth provisioning systems in the region. This could only be achieved by trying to uncover whether the people understand e-health, if and how they use it and what they gain from using eHealth applications.
Aproaching the gap

The overall approach to studying the scientific gap, was to first try and break down the seemingly simple idea in to adequate research questions, which would then drive the research. At first it was rather important to understand the trend in diabetes self-management applications, and to find out what the specific categories of applications provide to their respective users. It was the authors’ consideration that this research should not start without understanding the technological environment in which people exist.

Then, the applications had to be compared and evaluated with real-life evidence-based results, which were obtained from the literature review. The categories of apps were determined as – applications which support decision-making; Communication channels; Electronic health records; Education apps. The literature review presented evidence which showed that apps were most commonly used as a mean of communication between patients and caregivers for the sending of reminders to patients, to adhere to their medicine, and retrieving simple information to an electronic health record for the use of medication adherence as mentioned in the research of (Vervloet et al., 2011; 2012). The second most popular use of diabetes self-management applications was for dieting and weight management as mentioned in the thesis (Arsand, 2008; Mohan et al., 2008; Patrick et al., 2009).

During the research, the author decided to use popular model for predicting adoption and use of technology, ‘Technology Acceptance Model” (TAM). This describes that the factor influencing user’s intention to use and adopt a certain technology is its perceived usefulness, which in this research was high. Regardless of the popularity and effectiveness of this theoretical model, it can be stated that it partially limited the outcomes of the research. Since there is an extended model called the TAM 2, which adds external factors to the already existing model that influence the perceived usefulness, there could have been data which this research did not capture (Venkatesh, 2000).

The most important results of the research

It is of utmost importance to again mention that the general purpose of the research was to find the level of use and acceptance of eHealth technologies through the factors of relative advantage and complexity. Although that SPSS presented one of the two pairs which were tested to prove the theory with a negative value, it does not present definitive conclusions that
the users see no definitive advantage over traditional health monitoring methods. This anomaly might be due to the characteristics of the specific population which was studied. A larger research simple is needed in order to verify negative or positive influence over theoretical usefulness of diabetes self-management technologies.

Additional and major results of the research were the fact that 93% of the respondents were already using diabetes self-management applications and that 74.6 % of the users reported high usability rates. Although those results are isolated to the relatively small number of participants in the research and may not necessarily be generalized to the entire population or to other research samples, they show a curious trend which might have been neglected. By looking at the results and comparing to the literature review, it might be able to notice with some degree of uncertainty that, although the population of diabetics in Bulgaria is not well documented compared to others, it actually moves with its own pace of development. Or in other words, diabetics are trying to incorporate health self-managing apps in their daily lives, regardless of the fact that research on the topic is lacking behind, and that there, as of yet, might not be a proper healthcare infrastructure to help them make the most of those smart applications.

Another small detail which requires a degree of attention is that, the common use of diabetes self-management applications in the research sample matches the use of other groups of diabetics in other regions, as uncovered by the literature review. In the publications explored during the literature review authors such as (Wang et al., 2006; Sevick et al., 2008; Mao, Zhanh, Zhai, 2008) have researched that the most common uses for diabetes health-management applications is for medication adherence and monitoring food intake or dieting. It is unknown whether this is coincidental occurrence or there is a naturally occurring pattern. This thesis does not have answer. However, it might serve as a base to another possible research.

Research limitations

This thesis suffers from limitations that need to be taken into account when considering its contributions. Some of those limitations were affiliated with the topic itself and its unrecognized depth and complexity. Others were connected to time limitation and research skills of the author.
Typically, limitations are events which are beyond the control of the researcher, and very often can lead to decreased validity of a potential research. Although limitations vary in the different circumstances, one of the main limitations of each research is the research sample selected by the author.

In this thesis, the people who took part in administering the questionnaire were sampled based on a convenience factor and later, by the effect of snowballing. The reason for this was the difficulty in finding and contacting enough individuals with diabetes to take part in the study. This meant that the researcher had little control over the participants and could have possibly not included sample of wider population of people with diabetes. Further research with a larger sample from a larger population of the Bulgarians is needed in order to provide more accurate data. In addition, a questionnaire as a method of gathering data can very often unintentionally steer the sample group into answering questions which do not characterize with them and, misguide them to answer what the researcher needs for the purpose of the research.

Another limitation for the development of the thesis was the sample size. It is a well-known fact that a larger population can account for a more precise data, however, due to the fact that the author worked alone on this research, a larger sample could have caused large delays in processing the information.

It could be stated with certainty that the incredible depth of the topic of diabetes made it impossible to search, read, analyze and review all the literature concerned with self-management and eHealth technologies. Therefore, this raises the question about the inclusion and exclusion of written material, and whether some papers would have been deemed more relevant than others. Nevertheless, being only single reviewer, who had to search and read all the necessary information, could have hindered the miss of relevant documentation, since there were no arguments over interpretation and content criteria.

Future research

As already mentioned earlier the use of eHealth technologies in Bulgaria is not thoroughly studied and creates a gap in the scientific field. However, this makes it suitable for the development of various kinds of research and field tests which will allow the capture of relevant data, which will serve to fill the knowledge gap.
As a proposition for further development of the topic, researchers can base their interest on the results of this thesis, which was developed as a basis for such expansion of knowledge. First of all, a larger research sample might be used in addition to a new theoretical framework to allow a broader sample to be tested upon. One direction of research would be to try and verify the influencers of theoretical usefulness of diabetes self-management technologies. Another possible development, would be to try and evaluate the overall development of mhealth systems in the Bulgarian region, since this particular thesis only discusses a very small population of mhealth users. Therefore, more studies on the varieties of populations are needed in order to complete the purpose of expanding and improving mhealth systems.

However, the best possible direction for future research might be to expand this particular topic by trying to measure what exactly influences the use of mhealth applications to support health among diabetics. This would require dwelling deeper into measuring health outcomes from the use of mobile applications. The research should try to capture data from more respondents, not only users but also healthcare providers. Such a study can possibly generate enough data to validate the promotion of mhealth systems in the region. But it might also give ideas on how to develop sufficient healthcare infrastructure to help patients make the most of the smart applications self-managing health.
References


American Diabetes Association Diabetes Care 2004 Jan; 27(suppl 1): s5-s10. https://doi.org/10.2337/diacare.27.2007.S5


Cleland, J., Caldow, J., & Ryan, D. A qualitative study of the attitudes of patients and staff to the use of mobile phone technology for recording and gathering asthma data. *J Telemed Telecare*, 13(2), 85–89.


http://doi.org/10.1177/2040622314552071


Kyriacou, E., Pavlopoulos, S., Berler, A., Neophytou, M., Bourka, A., Georgoulas, A.,
(2003). Multi-Purpose HealthCare Telemedicine Systems with Mobile Communication Link


critical review of the technology acceptance model. Information and Management, 40, 191-
204.

Leonardi M et al. (2006). The definition of disability: what is in a name? Lancet, 368, 1219-
1221.

Leong, K. C., Chen, W. S., Leong, K. W., Mastura, I., Mimi, O., Sheikh, M. A., Zailinawati,
attendance in primary care: a randomized controlled trial. Fam Pract., 23(6), 699705.

Diabetes-Related Consumer Health Informatics Technologies. Journal of Diabetes Science
and Technology 7(4), doi: 10.1177/193229681300700429

Lester, R. T., Mills, E. J., Kariri, A., Ritvo, P., Chung, M., Jack, W., Habyarimana, J.,
Karanja, S., Barasa, S., Nguti, R., Estambale, B., Ngugi, E., Ball, T. B., Thabane, L., Kimani,
(WelTel Kenya1): a randomized controlled trial protocol. Trials., 10, 87,
doi:10.1186/174562151087

Li, F., Harmer, P., Cardinal, B. J., & Vongjaturapat, N. (2009). Built environment and


glycemic control without hypoglycemia in elderly diabetic patients using the ubiquitous
healthcare service, a new medical information system. Diabetes Care, 34(2):308-313.


Manuela, M. Miranda, M., Handbook of Research on ICTs and Management Systems for Improving Efficiency in Healthcare and Social Care 2013, DOI: 10.4018/978-1-4666-3990-4


Misra, S; Oliver, NS (28 October 2015). "Diabetic ketoacidosis in adults" (PDF). BMJ (Clinical research ed.). 351: h5660. doi:10.1136/bmj.h5660


<table>
<thead>
<tr>
<th>YEAR</th>
<th>AUTHOR</th>
<th>PURPOSE</th>
<th>RESULT</th>
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</thead>
<tbody>
<tr>
<td>2005</td>
<td>Ryan D, Cobern W, Wheeler J, Price D, Tarassenko L.</td>
<td>Mobile monitoring for self-managing asthma.</td>
<td>The research resulted in 69% of satisfaction of the system among the population and 74% indication that it also helped to self-manage the chronic condition.</td>
</tr>
<tr>
<td>2006</td>
<td>Puccio JA, Belzer M, Olson J, Martinez M, Salata C, Tucker D, Tanaka D.</td>
<td>Study the use of phone reminders to assist in antiretroviral therapy adherence.</td>
<td>The solution to use cell phone reminders was practical and acceptable for the patients. Most of them found the use of this technology useful and less intrusive.</td>
</tr>
<tr>
<td>2006</td>
<td>Milne RG, Horne M, Torsney B.</td>
<td>Impact of sms reminders on non-attenders in patient clinics in the UK</td>
<td>The study showed modest results, however it did show that clinics save 13$ per non-attender avoided.</td>
</tr>
<tr>
<td>2006</td>
<td>Kim HS, Kim NC, Ahn SH</td>
<td>Study the impact of nurse messages intervention for diabetics.</td>
<td>After 12 weeks in the research process, patients reported 1.1% decrease in HbA1c levels, and increased adherence to medication and physical activity.</td>
</tr>
<tr>
<td>2007</td>
<td>Geraghty M, Glynn F, Amin M, Kinsella J.</td>
<td>Study the non-attendance rate of patients in clinics after introducing text reminder system.</td>
<td>Before the introduction of the text system, non-attendance was 33.6 per cent. Following the system introduction, non-attendance rate fell to 22 per cent.</td>
</tr>
<tr>
<td>2007</td>
<td>Curioso WH, Kurth AE.</td>
<td>Use and perceptions of internet, mobile phones as means of health promotion.</td>
<td>Health interventions using ICT’s are acceptable and feasible. Individuals have positive perceptions about ICTS’ promoting health.</td>
</tr>
<tr>
<td>2007</td>
<td>Kollmann A, Riedl M, Kastner P, Schreier G, Ludvik B.</td>
<td>Diabetes self-management through tele medical interaction between patients with diabetes and health professionals.</td>
<td>The service was highly accepted among patients and was used frequently. Upon completing the study, data showed that HbA1c has decreased.</td>
</tr>
<tr>
<td>Year</td>
<td>Authors</td>
<td>Objective</td>
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<td>2007</td>
<td>Logan AG, McIsaac WJ, Tisler A, Irvine MJ, Saunders A, Dunai A, Rizo CA, Feig DS, Hamill M, Trudel M, Cafazzo JA</td>
<td>The objective of the study was to develop home tele management system which engages patients with diabetes in healthcare.</td>
<td>The study resulted in lowered blood pressure and showed that patients who use it accept it and perceive it as effective in self-managing health.</td>
</tr>
<tr>
<td>2008</td>
<td>Faridi Z, Liberti L, Shuval K, Northrup V, Ali A, Katz DL</td>
<td>Evaluating the impact of mobile technology on type 2 diabetes self-management.</td>
<td>The research showed that the first benefit of using the system was decreased HbA1c levels, and that self-efficacy increased.</td>
</tr>
<tr>
<td>2008</td>
<td>Morak J, Schindler K, Goerzer E, Kastner P, Toplak H, Ludvik B, Schreier G</td>
<td>The study aimed to assess the feasibility of web-based management system with mobile phone for managing obesity.</td>
<td>The system was experienced positive by the patients and data from the research showed that on average patients showed reductions in abdominal girth and in body mass.</td>
</tr>
<tr>
<td>2008</td>
<td>Quinn CC, Clough SS, Minor JM, Lender D, Okafor MC, Gruber-Baldini A</td>
<td>The aim of the study was to assess the impact on A1c of a mobile phone diabetes management software.</td>
<td>The initial result of the study was 2.03% decrease on A1c levels in patients with diabetes mellitus. It also reported that the system facilitated treatment decisions, provided organized data.</td>
</tr>
<tr>
<td>Year</td>
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<tr>
<td>2009</td>
<td>Curioso WH, Quistberg DA, Cabello R, Gozzer E, Garcia PJ, Holmes KK, Kurth AE</td>
<td>To characterize the effective patient care reminder strategies and to improve therapy using messages.</td>
<td>The study showed that patients liked to receive messages. The reported change in their behavior towards health and healthcare in general and, helped increase their self-esteem.</td>
</tr>
<tr>
<td>2009</td>
<td>Sahm L, MacCurtain A, Hayden J, Roche C, Richards HL.</td>
<td>The study aimed to assess the levels of self-reported medication adherence and to understand the acceptability of message reminders to non-adherers.</td>
<td>The study found out that 50% of the population were not adhering to medication unintentionally, and that 60% of the total population accepted the use of text message reminders for medication adherence.</td>
</tr>
<tr>
<td>2009</td>
<td>Cho JH, Lee HC, Lim DJ, Kwon HS, Yoon KH</td>
<td>Communication using a mobile phone with a glucometer for glucose control in Type 2 patients with diabetes</td>
<td>After three months, the test resulted in decreased HbA1c levels, and increased adherence to medication. Moreover, it improved the overall communication between doctors and patients.</td>
</tr>
<tr>
<td>2009</td>
<td>Quinn CC, Gruber-Baldini AL, Shardell M, Weed K, Clough SS, Peeples M, Terrin M, Bronich-Hall L, Barr E, Lender D.</td>
<td>Mobile diabetes intervention and communication for blood glucose control.</td>
<td>The primary outcome of the study was a decrease change in HbA1c.</td>
</tr>
<tr>
<td>2009</td>
<td>Holtz B, Whitten P.</td>
<td>Managing asthma with mobile phones.</td>
<td>The results showed that this treatment method is feasible and that it improves compliance with asthma action plans.</td>
</tr>
<tr>
<td>2010</td>
<td>Strandbygaard U, Thomsen SF, Backer V</td>
<td>Study the impact of daily message reminders on treatment adherence.</td>
<td>The study showed that adherence to therapy increased by 17.8%.</td>
</tr>
<tr>
<td>Year</td>
<td>Authors</td>
<td>Study Title</td>
<td>Summary</td>
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<td>2011</td>
<td>Mbuagbaw L, Thabane L, Ongolo-Zogo P, Lester RT, Mills E, Volmink J, Yondo D, Essi MJ, Bonono-Momnougui RC, Mba R, Ndongo JS, Nkoa FC, Ondoa HA</td>
<td>Trial of mobile phone text messaging versus usual care for improving adherence in therapy.</td>
<td>The study did not find a significant effect on improving attendance to therapy in a period of 6 months.</td>
</tr>
<tr>
<td>2011</td>
<td>Vervloet M, van Dijk L, Santen-Reestman J, van Vlijmen B, Bouvy ML, de Bakker DH</td>
<td>Evaluate the effect of real time medication monitoring on patients with diabetes.</td>
<td>The intervention proved to be effective and patients with type 2 diabetes reached higher adherence levels. Also, the system could be used on various patient populations to improve their adherence.</td>
</tr>
<tr>
<td>2011</td>
<td>Dick JJ, Nundy S, Solomon MC, Bishop KN, Chin MH, Peek ME.</td>
<td>Feasibility and usability of text messaging for diabetes self-management.</td>
<td>Participants in the study reported that messaging helped them self-manage diabetes, and that missed medication doses decreased significantly.</td>
</tr>
<tr>
<td>2011</td>
<td>Quinn CC, Shardell MD, Terrin ML, Barr EA, Ballew SH, Gruber-Baldini AL.</td>
<td>To test whether mobile application education would reduce glycated hemoglobin levels in diabetics compared to primary care.</td>
<td>The results from the study showed a decrease in glycated hemoglobin with 1.9%.</td>
</tr>
<tr>
<td>2012</td>
<td>Montes JM, Medina E, Gomez-Beneyto M, Maurino J.</td>
<td>Assess the impact of a short message service on adherence to antipsychotic treatment.</td>
<td>A significantly greater improvement in adherence was observed among patients receiving SMS text messages. And also, attitude towards medication was more positive.</td>
</tr>
<tr>
<td>2012</td>
<td>Vervloet M, van Dijk L, Santen-Reestman J, van Vlijmen B, van Wingerden P, Bouvy ML, de Bakker DH</td>
<td>The study aimed to investigate the effect of SMS reminders on adherence and the patients’ experience of the system.</td>
<td>Results showed that over 6-month period patients took more doses of their medication, and that the patients experienced the system positively.</td>
</tr>
<tr>
<td>2012</td>
<td>Foreman KF, Stockl KM, Le LB, Fisk E, Shah SM, Lew HC, Solow BK, Curtis BS.</td>
<td>To measure the level of medication adherence among patients who receive text message medication reminders.</td>
<td>The findings of the research pint that patients who used text message reminders tend to have higher medication adherence rates.</td>
</tr>
<tr>
<td>YEAR</td>
<td>AUTHOR</td>
<td>PURPOSE</td>
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<tr>
<td>2005</td>
<td>Gosselin P, Lebel G, Rivest S, Douville-Fradet M.</td>
<td>Public health monitoring in real time, using global information system.</td>
<td>The system proved to be useful as it allows data to be collected and analyzed through multiple regions for improved decision-making.</td>
</tr>
<tr>
<td>2006</td>
<td>Wang DH, Kogashiwa M, Kira S.</td>
<td>Testing mobile assistant with camera for assessing individual’s dietary intake.</td>
<td>The research shows that there are differences in recording dietary intake compared to traditional records. It also states that 57.1 per cent of the users found the method to be less time consuming and that they were willing to use it for longer time.</td>
</tr>
<tr>
<td>2006</td>
<td>Flahault A, Blanchon T, Dorléans Y, Toubiana L, Vibert JF, Valleron AJ.</td>
<td>System for virtual surveillance of communicable disease.</td>
<td>Computer-based information system was deployed to collect large amounts of data with individual description of cases, which were combined with mathematical theory to explore disease spread.</td>
</tr>
<tr>
<td>2007</td>
<td>Dale O, Hagen KB.</td>
<td>Aimed to assess how personal digital assistants serve as patient reporting tools</td>
<td>Electronic collection of data leads to reduction in time for data handling, better accuracy, and fewer errors in records.</td>
</tr>
<tr>
<td>2007</td>
<td>Heiberg T, Kvien TK, Dale Ø, Mowinckel P, Aanerud GJ, Songe-Møller AB, Uhlig T, Hagen KB</td>
<td>Aims to compare daily and weekly registrations of self-reported health status measures using digital assistants.</td>
<td>The research showed that missing data entries dropped by 82.9% and that patients preferred using the digital assistant.</td>
</tr>
<tr>
<td>2007</td>
<td>Tasker AP, Gibson L, Franklin V, Gregor P, Greene S.</td>
<td>Assessment of mobile phone technology and computer interviewing for documenting symptomatic mild hypoglycemia.</td>
<td>The research reported that 65% of the study group used mostly mobile phones to document their health. It also reported that test subjects found mobile documentation easier.</td>
</tr>
<tr>
<td>2008</td>
<td>Fowles ER, Gentry B.</td>
<td>To determine the feasibility of using digital technology for tracking food intake.</td>
<td>Entering data into a digital device proved to be easier than 24-hour recall of actions. Users of the device stated that it was also more accurate.</td>
</tr>
<tr>
<td>Year</td>
<td>Authors</td>
<td>Title</td>
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<tr>
<td>2008</td>
<td>Galliher JM, Stewart TV, Pathak PK, Werner JJ, Dickinson LM, Hickner JM</td>
<td>Compare the completeness of data collection using pen and paper against data entry into handheld computers.</td>
<td>The research showed that data omission on paper was very high compared to data on computers.</td>
</tr>
<tr>
<td>2008</td>
<td>Siracuse MV, Sowell JG</td>
<td>To describe the use of digital assistants by doctors and determine technology acceptance of PDA use.</td>
<td>Devices were often used by doctors and were strongly correlated with perceived usefulness and compatibility.</td>
</tr>
<tr>
<td>2008</td>
<td>Bernabe-Ortiz A, Curioso WH, Gonzales MA, Evangelista W, Castagnetto JM, Carcamo CP, Hughes JP, Garcia PJ, Garnett GP, Holmes KK</td>
<td>Evaluation of the quality of behavior data collected with handheld device compared to paper-based questionnaires.</td>
<td>The study showed that the rate of use of handheld devices is greater than the paper-based solution. And also, that there were less inconsistencies and missing values with the mobile system.</td>
</tr>
<tr>
<td>2008</td>
<td>Blaya JA, Gomez W, Rodriguez P, Fraser H</td>
<td>Cost and implementation of digital assistant system.</td>
<td>The study shows that data collection and analysis fell by 60%, and that system implementation costs were very low.</td>
</tr>
<tr>
<td>2008</td>
<td>Vanmeulebrouk B, Rivett U, Ricketts A, Loudon M</td>
<td>Research the possibility to develop an information system for local level management if HIV/AIDS.</td>
<td>Usability tests in the study reported high degree of system usability.</td>
</tr>
<tr>
<td>2009</td>
<td>Blaya JA, Cohen T, Rodriguez P, Kim J, Fraser HS</td>
<td>The objective was to evaluate the effectiveness of digital assistant-based system for collecting tuberculosis test results.</td>
<td>The system had significant effect on decreasing time for data processing and errors (57%).</td>
</tr>
<tr>
<td>2009</td>
<td>Yang C, Yang J, Luo X, Gong P</td>
<td>Use of mobile phones for disease reporting.</td>
<td>After delivering the service to several counties, the total number of reporting was highest (52.9%) with the mobile devices.</td>
</tr>
<tr>
<td>2009</td>
<td>Kim AA, Martinez AN, Klausner JD, Goldenson J, Kent C, Liska S, McFarland W</td>
<td>To utilize information systems to monitor trends in HIV prevalence.</td>
<td>The system proved useful in mapping the spatial distribution of the disease, and identified risk patterns for vulnerable population of women.</td>
</tr>
<tr>
<td>2010</td>
<td>Horst MA, Coco AS</td>
<td>Using electronic health records to track the development of common illness across a community.</td>
<td>The study was able to produce a geographic information system which was able to assess the amount of visit rates for common illnesses in a community, and it was able to predict their spread over time.</td>
</tr>
<tr>
<td>Year</td>
<td>Authors</td>
<td>Study Title</td>
<td>Study Description</td>
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<tr>
<td>2010</td>
<td>Kelly GC, Hii J, Batarii W, Donald W, Hale E, Nausien J, Pontifex S, Vallely A, Tanner M, Clements A.</td>
<td>Using digital assistants to define spatial distribution of malaria elimination interventions.</td>
<td>Data generation from such systems proved to be useful in defining the spatial distribution of the disease. The data was used for strategic implementation and deployment of medical interventions.</td>
</tr>
<tr>
<td>2011</td>
<td>Magee M, Isakov A, Paradise HT, Sullivan P.</td>
<td>Determine the feasibility and acceptability of two-way text message communication during disaster events.</td>
<td>The study resulted in high feasibility of communication for surveillance. Such methods could provide timely data during health critical events.</td>
</tr>
<tr>
<td>2012</td>
<td>Whitford HM, Donnan PT, Symon AG, Kellett G, Monteith-Hodge E, Rauchhaus P, Wyatt JC.</td>
<td>To test the reliability, acceptability and practicality of messaging for data collection.</td>
<td>The research reported that messaging reliability and data validity were in perfect agreement. Most of the participants in the study found the method of data collection to be convenient and acceptable.</td>
</tr>
<tr>
<td>2012</td>
<td>Jian WS, Hsu MH, Sukati H, Syed-Abdul S, Scholl J, Dube N, Hsu CK, Wu TJ, Lin V, Chi T, Chang P, Li YC.</td>
<td>Providing remote clinics with laboratory test results via messaging systems.</td>
<td>The study shows that the turnaround time for blood tests was decreased, and that loss of records was brought down by a great margin.</td>
</tr>
<tr>
<td>2013</td>
<td>Kelly GC, Hale E, Donald W, Batarii W, Bugoro H, Nausien J, Smale J, Palmer K, Bobogare A, Taleo G, Vallely A, Tanner M, Vestergaard LS, Clements AC.</td>
<td>Using spatial decision support systems to locate and map disease cases, and to rapidly respond to elimination zones.</td>
<td>The use of the system demonstrated high resolution approach to understanding the epidemiological variation within areas and to consider logistic constraints and costs for targeting the affected areas.</td>
</tr>
<tr>
<td>YEAR</td>
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<td>PURPOSE</td>
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<tr>
<td>2006</td>
<td>Franklin VL, Waller A, Pagliari C, Greene S.A.</td>
<td>A test trial of text-messaging system for young people with diabetes.</td>
<td>The system was associated with improved self-efficacy and medication adherence and had role in introducing insulin therapy.</td>
</tr>
<tr>
<td>2006</td>
<td>Waller A, Franklin V, Pagliari C, Greene S.</td>
<td>Design of a text-message scheduling system to support young people with diabetes.</td>
<td>The research showed that a software developer and a clinician produced a reliable, functional and acceptable system which has the potential to support health and behavior.</td>
</tr>
<tr>
<td>2006</td>
<td>Choi J, Yoo S, Park H, Chun J.</td>
<td>Proposition of mobile medical information system which distributes patient data across sources and accesses them through mobile device.</td>
<td>The system showed that it is reliable and fast to be able to support clinical communication.</td>
</tr>
<tr>
<td>2006</td>
<td>Stephen Chau; Paul Turner</td>
<td>Implementation of wireless handheld devices in clinical care management.</td>
<td>The system trial produced insights on the development of mobile technologies to support health. The paper outlines that by enabling two-way transmission of clinical information to the point of care, will be beneficial.</td>
</tr>
<tr>
<td>2006</td>
<td>Blaya J, Fraser HS.</td>
<td>Use of handheld management system for collection of tuberculosis data.</td>
<td>The use of the system resulted in 54.8% decrease in information processing times. It was also able decrease discrepancy by 10%, and also lead to saving due to work efficiency.</td>
</tr>
<tr>
<td>2006</td>
<td>Choi M, Afzal B, Sattler B.</td>
<td>Developing systems for healthcare providers and communities to assess exposure to health risks, self-reported health information.</td>
<td>The system was found to be a useful tool for displaying environment risk and potential health effects.</td>
</tr>
<tr>
<td>Year</td>
<td>Authors</td>
<td>Title</td>
<td>Abstract</td>
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<tr>
<td>2007</td>
<td>Benhamou PY, Melki V, Boizel R, Perreal F, Quesada JL, Bessieres-Lacombe S, Bosson JL, Halimi S, Hanaire H.</td>
<td>Intensive coaching using web and cellular for data transmission of patients treated with continuous subcutaneous insulin infusion.</td>
<td>The study observed reduction in HbA1c and glucose values during 6-month test period. The analysis of the data also showed significant improvement in quality of life.</td>
</tr>
<tr>
<td>2007</td>
<td>Brock TP, Smith SR.</td>
<td>Evaluate the effects of patient education in clinical setting by using digital devices.</td>
<td>The study shows that during the test periods, the patients showed improvement in knowledge of the disease, medications and self-reported adherence.</td>
</tr>
<tr>
<td>2008</td>
<td>Arsand E, Tufano JT, Ralston JD, Hjortdahl P.</td>
<td>Design of mobile dietary management system for people with diabetes</td>
<td>The study tested the system on adults with type 1 and type 2 diabetes and found serious implications for the use of mobile dietary management system.</td>
</tr>
<tr>
<td>2008</td>
<td>Sevick MA, Zickmund S, Korytkowski M, Piraino B, Sereika S, Mihalko S, Snetselaar L, Stumbo P, Hausmann L, Ren D, Marsh R, Sakraida T, Gibson J, Safaien M, Starrett TJ, Burke LE.</td>
<td>Designing of an intervention using personal device for monitoring and managing type 2 diabetes.</td>
<td>The initial results of the study show that the use of the system lead to 85% retention rate of patients. Moreover, 88% of the patients reported that the system was useful, easy to use and was easy to interpret the feedback graphs.</td>
</tr>
<tr>
<td>2008</td>
<td>Mao Y1, Zhang Y, Zhai S.</td>
<td>Delivering individualized pharmaceutical care via text messages sent to patients.</td>
<td>The results of the study indicated that patients were highly satisfied with the system. It also widened the knowledge of pharmacists and improved the effect and safety of the medications.</td>
</tr>
<tr>
<td>2008</td>
<td>Mohan P, Marin D, Sultan S, Deen A.</td>
<td>Using mobile telephony to personalize the self-care process for patients with diabetes.</td>
<td>The system was developed with a reasoning engine which made recommendations to a patient based on current and previous readings from other monitoring devices.</td>
</tr>
<tr>
<td>2008</td>
<td>Gao S, Mioc D, Anton F, Yi X, Coleman DJ.</td>
<td>Mapping and sharing disease information using geographical information systems.</td>
<td>The system enabled cross border visualization, analysis and sharing of disease information through interactive maps with multiple partners over a network.</td>
</tr>
<tr>
<td>Year</td>
<td>Authors</td>
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<tr>
<td>2009</td>
<td>Free C, Whittaker R, Knight R, Abramsky T, Rodgers A, Roberts IG.</td>
<td>Controlled trial of mobile phone smoking cessation support.</td>
<td>The system reported double self-reported quit rate in the short term.</td>
</tr>
<tr>
<td>2009</td>
<td>Hanauer DA, Wentzell K, Laffel N, Laffel LM.</td>
<td>Comparison of cell phone messaging to other reminders for blood glucose monitoring.</td>
<td>Cell phone messaging for blood glucose monitoring is viable and acceptable. During the test period, phone users reported 30% more blood glucose data.</td>
</tr>
<tr>
<td>2009</td>
<td>Patrick K, Raab F, Adams MA, Dillon L, Zabinski M, Rock CL, Griswold WG, Norman GJ.</td>
<td>Trial of a message system for weight loss.</td>
<td>The study reports that for a period of 4 months the users lost 2 kg more weight than a standard test group.</td>
</tr>
<tr>
<td>2009</td>
<td>Yu P, de Courten M, Pan E, Galea G, Pryor J.</td>
<td>Development of personal digital assistant data collection system.</td>
<td>The research points out that 62% of the users perceived the system easy to use and the operations to be completed. Also, data entry and validation were reduced by 93.26% compared to traditional methods. Moreover, the research showed that such a system is a feasible solution for public health surveillance data collection.</td>
</tr>
<tr>
<td>2011</td>
<td>Schuurman N, Randall E, Berube M.</td>
<td>Spatial decision support system for remote health providers.</td>
<td>The report shows that such a system proved to enable decision-makers to estimate population specific health services, and to determine multiple scenarios for allocation of health services.</td>
</tr>
<tr>
<td>2012</td>
<td>Altuwaijri MM, Sughayr AM, Hassan MA, Alazwari FM.</td>
<td>Integrating messaging reminders with electronic medical records on non-attendance rates.</td>
<td>The integration of sms system in hospitals decreased the non-attendance rate of patients from 23.9% to 19.8%. Thus, the system provided a positive effect on reduction of non-attendance.</td>
</tr>
<tr>
<td>YEAR</td>
<td>AUTHOR</td>
<td>PURPOSE</td>
<td>RESULT</td>
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<tr>
<td>------</td>
<td>--------</td>
<td>---------</td>
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</tr>
<tr>
<td>2005</td>
<td>Bielli E, Carminati F, La Capra S, Lina M, Brunelli C, Tamburini M.</td>
<td>Development of wireless health monitoring system for cancer patients using mobile phone.</td>
<td>The system allowed custom questionnaires to be send to patients by a medical team. Upon completion, the team send them graph with their state of health. Moreover, the research provides information that 56% of the patients wanted to use the news system.</td>
</tr>
<tr>
<td>2006</td>
<td>Menon-Johansson AS, McNaught F, Mandalia S, Sullivan AK.</td>
<td>To assess the effectiveness of messaging within health clinic for the treatment of genital disease.</td>
<td>The research showed that during the early stages of testing, the messaging system managed to save 46 working hours per month. Moreover, the average days for diagnosing and treatment was brought down to 8 days.</td>
</tr>
<tr>
<td>2006</td>
<td>Scanaill CN, Ahearne B, Lyons GM.</td>
<td>Use sms messaging to monitor mobility trends of elderly people.</td>
<td>The system used was able to integrate an accelerometer attached to each monitored. Each person’s mobility levels were monitored, and medical personal was alerted if the movements stopped.</td>
</tr>
<tr>
<td>2006</td>
<td>Leong KC, Chen WS, Leong KW, Mastura I, Mimi O, Sheikh MA, Zailinawati AH, Ng CJ, Phua KL, Teng CL.</td>
<td>To determine the effectiveness of a text messaging reminder for improving attendance.</td>
<td>The research proved that the attendance rate of patients using text messages was higher versus control groups.</td>
</tr>
<tr>
<td>2007</td>
<td>Carroll AE, Marrero DG, Downs SM.</td>
<td>Usability study of mobile technology which is directed towards self-management of type 1 diabetes with glucose monitoring device.</td>
<td>The result of the study shows that test subjects who used the system agreed that the glucometer was easy to use and also, that it was useful in managing diabetes.</td>
</tr>
<tr>
<td>2007</td>
<td>Kim HS</td>
<td>To investigate the effects of educational intervention through short messages related to plasma glucose levels.</td>
<td>The educational intervention improved HbA1c and 2HPMG levels in patients who used it. The mean decrease of HbA1c was 1.12% and that of 2HPMG was lower with 04.7 mmol/l.</td>
</tr>
<tr>
<td>2007</td>
<td>Kim HS, Jeong HS</td>
<td>To investigate the effectiveness of blood glucose management</td>
<td>During the three months of the research the test was able to provide a decrease in HbA1c levels by 1.15%. Also, patients had</td>
</tr>
<tr>
<td>Year</td>
<td>Authors</td>
<td>Title</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>---------</td>
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</tr>
<tr>
<td>2007</td>
<td>Odero W, Rotich J, Yiannoutsos CT, Ouna T, Tierney WM.</td>
<td>Application of information technology in disease surveillance and prevention.</td>
<td>The system was used to upload medical data and to create digital maps of injury spatial distribution, and to correlate injury type and location with patient’s clinical data.</td>
</tr>
<tr>
<td>2008</td>
<td>Koshy E, Car J, Majeed A</td>
<td>Testing the effectiveness of messages to decrease non-attendance in healthcare delivery.</td>
<td>The use of short messages as reminders for patients resulted in decrease in non-attendance by 38%. It also proved that using justs messaging is less labor intensive and drives down costs.</td>
</tr>
<tr>
<td>2008</td>
<td>Chen ZW, Fang LZ, Chen LY, Dai HL.</td>
<td>To compare the efficacy of short messaging system and phone reminder to improve attendance in a clinic.</td>
<td>After the analysis, the research showed that the attendance rates were significantly higher with the new system.</td>
</tr>
<tr>
<td>2008</td>
<td>Kruger DJ, Brady JS, Shirey LA.</td>
<td>Using information system to facilitate health planning for diabetes intervention efforts.</td>
<td>Data were used to geographically map diabetes risk-scores and diabetes screening rates. Those maps indicated the estimated areas of risk with diabetes were the ones with lower screening levels.</td>
</tr>
<tr>
<td>2009</td>
<td>Gerber BS, Stolley MR, Thompson AL, Sharp LK, Fitzgibbon ML.</td>
<td>Feasibility study of text messaging to promote healthy eating behaviors.</td>
<td>The result of the study was great positivity towards the messaging system, and that it promoted a feasible and acceptable way to promote weight management.</td>
</tr>
<tr>
<td>2009</td>
<td>Li F, Harmer P, Cardinal BJ, Vongjaturapat N.</td>
<td>Examine the environment and health behavior and their relation to blood pressure for patients with cardio-vascular disease.</td>
<td>A significant relationship was found between blood pressure and area of living. The study showed that blood pressure depended on neighborhood walkability, density of fast food outlets.</td>
</tr>
<tr>
<td>2009</td>
<td>Poulou T, Elliott SJ.</td>
<td>Identification of spatial clusters of overweight and obesity.</td>
<td>The study revealed geographical variations in overweight and obesity prevalence.</td>
</tr>
<tr>
<td>Year</td>
<td>Authors</td>
<td>Study Title</td>
<td>Study Details</td>
</tr>
<tr>
<td>------</td>
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</tr>
<tr>
<td>2010</td>
<td>Bramanti A, Bonanno L, Celona A, Bertuccio S, Calisto A, Lanzafame P, Bramanti P.</td>
<td>The study focuses on identifying regional locations for telemedicine service through a computer system, which allows neurology to be practiced when the doctor and the patient are not present in the same palace.</td>
<td>The system improved the quality of life of patients by providing continuous care which eliminates travel costs.</td>
</tr>
<tr>
<td>2011</td>
<td>Schembre SM, Yuen J.</td>
<td>Feasibility study, testing the use of automated messaging to monitor appetite ratings.</td>
<td>The result of the study was that, in the system was used daily with minor variations, and that 74% of the users showed high compliance with using it.</td>
</tr>
<tr>
<td>2011</td>
<td>Perry JG</td>
<td>The aim of the study was to assess whether short message reminders will improve attendance rates.</td>
<td>Patients who used sms readily accepted the new mean of communication. In doing so, it drove non-attendance rates to just 14%.</td>
</tr>
<tr>
<td>2012</td>
<td>de Niet J, Timman R, Bauer S, van den Akker E, Buijks H, de Klerk C, Kordy H, Passchier J.</td>
<td>The study analyzes whether self-monitoring of lifestyle behavior through short message will positively affect weight and psychological wellbeing of obese children.</td>
<td>The study provided data which contributed to the idea that short messages can be a feasible treatment delivery.</td>
</tr>
<tr>
<td>2012</td>
<td>Prasad S, Anand R</td>
<td>Delivering reminders to patients via short messaging service, to study the effect of patient attendance.</td>
<td>After the research, the rate of attendance of using sms was significantly higher (79.2%).</td>
</tr>
<tr>
<td>YEAR</td>
<td>AUTHOR</td>
<td>PURPOSE</td>
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<tr>
<td>2005</td>
<td>Buck DS, Rochon D, Turley JP.</td>
<td>Recording personal medical data on digital devices.</td>
<td>Preliminary data of the tests suggests, that clinicians who used digital devices to record medical data, had the ability and time to build relationships with customers instead of constantly recreating paperwork.</td>
</tr>
<tr>
<td>2005</td>
<td>Hsieh CH, Jeng SF, Chen CY, Yin JW, Yang JC, Tsai HH, Yeh MC</td>
<td>To test the feasibility of consultation with mobile camera-phone to transfer clinical images.</td>
<td>During the study, doctors were able to successfully complete the remote diagnosing on 80% of the patients.</td>
</tr>
<tr>
<td>2007</td>
<td>Cleland J, Caldow J, Ryan D.</td>
<td>Qualitative study of the attitudes of patients with asthma and staff for recording data on mobile devices.</td>
<td>By using electronic peak flow meter attached to a mobile device, allowed patients and doctors to identify poor control quicker, and to communicate without the need for face-to-face visit. There was a high degree of acceptability of this technology among patients and staff.</td>
</tr>
<tr>
<td>2007</td>
<td>Joo NS, Kim BT.</td>
<td>Using short messages to deliver weight control program.</td>
<td>Upon completion of the research, data showed that 47% of the patients who used this system managed to successfully complete their weight management program. Moreover, data also shows that there was a significant loss in weight and waist circumference. A short interview with the users revealed that they were very satisfied with the system.</td>
</tr>
<tr>
<td>2008</td>
<td>Kuiper R</td>
<td>Use of digital assistants to support clinical reasoning among nursing students.</td>
<td>The research reached to the conclusion that, personal devices have implications to deliver accurate diagnosing, reduction in medical errors, reduction in healthcare costs and a new way to develop treatment.</td>
</tr>
<tr>
<td>Year</td>
<td>Authors</td>
<td>Summary</td>
<td>Details</td>
</tr>
<tr>
<td>------</td>
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<td>------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2010</td>
<td>Hsieh JC, Lin BX, Wu FR, Chang PC, Tsuei YW, Yang CC</td>
<td>To demonstrate the transmission of electrocardiography data in an ambulance to the cellphone of a cardiologist.</td>
<td>The system allows ECG files to be sent through a wireless network to a processing server in a hospital. Then the data is sent to the mobile phones of cardiologists. As a consequence, doctors have the ability to elaborate on the ECG data to prepare for the most appropriate treatment in advance.</td>
</tr>
<tr>
<td>2012</td>
<td>Fischer HH, Moore SL, Ginosar D, Davidson AJ, Rice-Peterson CM, Durfee MJ, MacKenzie TD, Estacio RO, Steele AW</td>
<td>To assess the feasibility of engaging adults with diabetes self-management by using text messaging, in order to provide blood sugar measurements.</td>
<td>The data from the research shows that 67.3% of the adults were active participants in the tests, and that more than 79% actually sent sugar levels data regularly. The patients themselves reported that they feel more accountable, that they are more aware of their health.</td>
</tr>
</tbody>
</table>
Table 6.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>AUTHOR</th>
<th>PURPOSE</th>
<th>RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>Grasso MA, Yen MJ, Mintz ML.</td>
<td>Identify trends in the utilization and acceptance of handheld computers among medical students.</td>
<td>The survey revealed that handheld computers were mainly used for drug referencing and clinical calculators. However, all participants predicted that use will increase significantly.</td>
</tr>
<tr>
<td>2006</td>
<td>Goldsworthy S, Lawrence N, Goodman W.</td>
<td>Examine the relationships between mobile devices and self-efficacy nursing students.</td>
<td>The study revealed that there are educational benefits of mobile devices. It also reported that on average, those students who did use handhelds did show increased levels of self-efficacy, compared to a control group.</td>
</tr>
<tr>
<td>2008</td>
<td>Farrell MJ, Rose L.</td>
<td>Use of handheld computers in clinical education.</td>
<td>The handhelds are used for pharmacological and clinical contextual knowledge. The devices did help students improve their pharmacological and medical knowledge and that they found the devices to be easy to implement in their education.</td>
</tr>
<tr>
<td>2010</td>
<td>Strayer SM, Pelletier SL, Martindale JR, Rais S, Powell J, Schorling JB.</td>
<td>Using handheld digital assistants to improve medical counseling on smoking cessation.</td>
<td>Smoking cessation counseling skill increased among all participants in the study. However, the testing period was not long enough to show any significant behavior changes.</td>
</tr>
</tbody>
</table>
Table 7.

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<tr>
<th>rAdvantage</th>
<th>Pearson Correlation</th>
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Table 8.

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<td>71,00</td>
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<th>Sig. (2-tailed)</th>
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<td>PEU</td>
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<td>1</td>
<td>Bant: a diabetes application for the epatient</td>
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<td>2</td>
<td>Glucose Buddy: Diabetes Helper</td>
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<td>3</td>
<td>Diabetes Buddy Lite: Control your Blood Sugar</td>
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<td>4</td>
<td>Diabetes Glucose Tracker Application (iDiabetes)</td>
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<td>Diabetes Pal by Telecare: Blood Glucose Manager</td>
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<td>6</td>
<td>Diabetes Diary</td>
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<td>7</td>
<td>LogFrog DB-A Leap in Diabetes</td>
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<td>8</td>
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<td>11</td>
<td>Gestational Diabetes Management</td>
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<td>RapidCalc Insulin Dose</td>
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<td>Glucose Tracker: Simple and Complete Application to track Diabetes Mellitus</td>
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<td>15</td>
<td>BlueLoop</td>
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<td>Diabetes Teams Lite</td>
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<td>Insulin Dose Advisor</td>
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<td>Glucose Pro</td>
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<td>GlucoPlus</td>
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<td>20</td>
<td>Glucose Tracker: Log and Monitor</td>
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<td>21</td>
<td>Diabetes 360</td>
</tr>
<tr>
<td>22</td>
<td>Blood Pal: free glucose tracker</td>
</tr>
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<td>23</td>
<td>Dia-Log</td>
</tr>
<tr>
<td>24</td>
<td>Your Diabetes Guardian</td>
</tr>
</tbody>
</table>


Appendix
Survey questions

Use of mobile applications for self-managing diabetes: Survey

SECTION A

How old are you?

☐ 0-20
☐ 21-30
☐ 31-40
☐ 41-50
☐ 51-60
☐ Older

What is your gender

☐ Male
☐ Female
☐ Non-specified

What type of diabetes do you have?

☐ Type 1
☐ Type 2
How many years have you been diabetic

☐ 0-5
☐ 6-15
☐ 16-25
☐ 26-35
☐ 35-45
☐ More

Section B

How often do you visit doctor about your diabetes?

☐ More than once a month
☐ Once a Month
☐ Less than once a month

Does your doctor give you feedback regarding your health?

☐ Yes
☐ No

Do you think you know what diabetes is?

☐ Yes
☐ No
What factors do you think are the most important for managing your health?

- Diet
- Exercise
- Medication
- Blood Sugar Level
- All

What is your level of IT knowledge (computer skills)?

- High
- Medium
- Small
- None

What is your mobile phone knowledge level?

- High
- Medium
- Small
- None

(Trialability)-Do you see yourself trying diabetes self-management apps to see if they benefit you?

- Yes
- No
Section C

Do you use diabetes self-management mobile applications? *

☐ Yes
☐ No

What do you use the applications for?

☐ Online diabetes education
☐ Healthy eating
☐ Insulin dose calculators
☐ Physical activity monitoring
☐ Monitoring blood glucose levels
☐ Medication adherence

How often do you use diabetes tracking apps on your phone?

☐ Everyday
☐ Several times a week
☐ Once in a while

How would you agree with the following statement? “Mobile services for (patient support/self management of health) within healthcare are becoming more common.”

Mark only one oval.

1  2  3  4  5

<table>
<thead>
<tr>
<th>Strongly agree</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Disagree</td>
<td></td>
</tr>
</tbody>
</table>
Do mobile health applications give you advantages over your overall health management?

Mark only one oval.

1 2 3 4 5

<table>
<thead>
<tr>
<th>Strongly agree</th>
<th></th>
<th></th>
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<th></th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

Section D

(Compatibility)-Are diabetes self management apps compatible with your current needs and past experiences with similar technology?

☐ Yes

☐ No

(Complexity)-Do you think that diabetes self management apps are complex to use?

☐ Yes

☐ No

(Relative advantage)-Do diabetes self-management apps give you an advantage for easily maintaining good health?

☐ Yes

☐ No

(Observability)-Do you think or do you know if other people experience positive outcomes from using such apps?

☐ Yes

☐ No
Do you think diabetes self-management apps can be beneficial in improving and promoting health?

- Yes
- No
- Maybe

Do you think the apps are easy to learn?

- Yes
- No

Do apps allow you to take active role in your healthcare?

- Yes
- No

Do apps allow you to better understand your health?

- Yes
- No

Do apps make it possible for you to make decisions regarding your health?

- Yes
- No

Do you think that diabetes apps should be in a native language rather in a foreign one, in order to be easy to use?

- Yes
- No
Do you think that diabetes self-management apps should provide more than one function at a time in order to be more effective?

☐ Yes

☐ No
Survey response Summary

SECTION A

How old are you?
19.7% 14.1% 28.2% 26.8%

0-20 8
21-30 19
31-40 20
41-50 10
51-60 14
Older 0

0-20 8 11.3%
21-30 19 26.8%
31-40 20 28.2%
41-50 10 14.1%
51-60 14 19.7%
Older 0 0%

What is your gender
50.7% 39.4%

Male 28
Female 36
Non-specified 7

Male 28 39.4%
<table>
<thead>
<tr>
<th>Gender</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>36</td>
<td>50.7%</td>
</tr>
<tr>
<td>Non-specified</td>
<td>7</td>
<td>9.9%</td>
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</tbody>
</table>

What type of diabetes do you have?

<table>
<thead>
<tr>
<th>Type</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>19</td>
<td>26.8%</td>
</tr>
<tr>
<td>Type 2</td>
<td>52</td>
<td>73.2%</td>
</tr>
</tbody>
</table>

How many years have you been diabetic

<table>
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<tr>
<th>Years</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>23</td>
<td>32.4%</td>
</tr>
<tr>
<td>6-15</td>
<td>22</td>
<td>31%</td>
</tr>
<tr>
<td>16-25</td>
<td>14</td>
<td>19.7%</td>
</tr>
<tr>
<td>26-35</td>
<td>8</td>
<td>11.3%</td>
</tr>
<tr>
<td>35-45</td>
<td>4</td>
<td>5.6%</td>
</tr>
</tbody>
</table>
Section B

How often do you visit doctor about your diabetes?

59.2% 29.6%

More than once a month 8
Once a Month 21
Less than once a month 42

More than once a month 8 11.3%
Once a Month 21 29.6%
Less than once a month 42 59.2%

Does your doctor give you feedback regarding your health?

98.6%

Yes 70
No 1

Yes 70 98.6%
No 1 1.4%

Do you think you know what diabetes is?

87.3%

Yes 62
No 9

Yes 62 87.3%
What factors do you think are the most important for managing your health?

- Diet: 12 (16.9%)
- Exercise: 5 (7%)
- Medication: 28 (39.4%)
- Blood Sugar Level: 1 (1.4%)

All: 25 (35.2%)

What is your level of IT knowledge (computer skills)?

- High: 21 (29.6%)
- Medium: 28 (39.4%)
- Small: 21
- None: 1

High: 21 (29.6%)

Medium: 28 (39.4%)

No: 9 (12.7%)
<table>
<thead>
<tr>
<th>Knowledge Level</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>31</td>
<td>43.7%</td>
</tr>
<tr>
<td>Medium</td>
<td>24</td>
<td>33.8%</td>
</tr>
<tr>
<td>Small</td>
<td>16</td>
<td>22.5%</td>
</tr>
<tr>
<td>None</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

What is your mobile phone knowledge level?
22.5% 33.8% 43.7%

(Trialability)-Do you see yourself trying diabetes self-management apps to see if they benefit you?
100%
Yes 71
No 0

Yes 71 100%
No 0 0%

Section C
Do you use diabetes self-management mobile applications?
7% 93%
Yes 66
No 5
Yes 66 93%
No 5 7%

What do you use the applications for?

<table>
<thead>
<tr>
<th>Question</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online diabetes education</td>
<td>11</td>
</tr>
<tr>
<td>Healthy eating</td>
<td>35</td>
</tr>
<tr>
<td>Insulin dose calculators</td>
<td>2</td>
</tr>
<tr>
<td>Physical activity monitoring</td>
<td>26</td>
</tr>
<tr>
<td>Monitoring blood glucose levels</td>
<td>8</td>
</tr>
<tr>
<td>Medication adherence</td>
<td>43</td>
</tr>
</tbody>
</table>

How often do you use diabetes tracking apps on your phone?

45.5% 47%
Everyday 31
Several times a week 30
Once in a while 5

Everyday 31 47%
Several times a week 30 45.5%
Once in a while 5 7.6%

How would you agree with the following statement? “Mobile services for (patient support/self management of health) within healthcare are becoming more common.”

123450120203040

Question Count
1 0
2 10
3 14
4 7
5 40

Strongly agree: 1 0 0%
2 10 14.1%
3 14 19.7%
4 7 9.9%

Strongly Disagree: 5 40 56.3%

Do mobile health applications give you advantages over your overall health management?

123450510152025
Section D

(Compatibility)-Are diabetes self management apps compatible with your current needs and past experiences with similar technology?

36.6% 63.4%

Yes 45

No 26

Yes 45 63.4%

No 26 36.6%

(Complexity)-Do you think that diabetes self management apps are complex to use?

53.5% 46.5%

Yes 33
(Relative advantage) Do diabetes self-management apps give you an advantage for easily maintaining good health?

No 38
Yes 33
46.5%

Do you think diabetes self-management apps can be beneficial in improving and promoting health?

No 22
Yes 49
49.6%

Do you think diabetes self-management apps give you an advantage for easily maintaining good health?

No 38
Yes 33
46.5%

Relative advantage) Do diabetes self-management apps give you an advantage for easily maintaining good health?

No 38
Yes 33
46.5%

Do diabetes self-management apps give you an advantage for easily maintaining good health?

No 38
Yes 33
46.5%

Do you think diabetes self-management apps give you an advantage for easily maintaining good health?

No 38
Yes 33
46.5%

Do diabetes self-management apps give you an advantage for easily maintaining good health?

No 38
Yes 33
46.5%

Do diabetes self-management apps give you an advantage for easily maintaining good health?

No 38
Yes 33
46.5%

Do diabetes self-management apps give you an advantage for easily maintaining good health?

No 38
Yes 33
46.5%

Do diabetes self-management apps give you an advantage for easily maintaining good health?

No 38
Yes 33
46.5%
Do you think the apps are easy to learn?

46.4%  53.6%

Yes 37
No 32

Do apps allow you to take active role in your healthcare?

34.3%  65.7%

Yes 46
No 24

Do apps allow you to better understand your health?

14.1%  85.9%

Yes 10
No 61
Do apps make it possible for you to make decisions regarding your health?

21.1% 78.9%

Yes 15
No 56

Do you think that diabetes apps should be in a native language rather in a foreign one, in order to be easy to use?

7% 93%

Yes 66
No 5

Do you think that diabetes self-management apps should provide more than one function at a time in order to be more effective?

35.2% 64.8%

Yes 46
No 25