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A Continuance Model for a Mobile/Web Based Self-Management System for Adolescent Diabetics: The Role of Loyalty Incentive

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A CONTINUANCE MODEL FOR A MOBILE/WEB BASED SELF-MANAGEMENT SYSTEM FOR ADOLESCENT DIABETICS: THE ROLE OF LOYALTY INCENTIVES

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Abstract

It is estimated that 200 children per day worldwide develop Juvenile Diabetes (JD). There is no cure for JD, therefore treatment protocols focus on controlling the disease. Several information systems (IS) have been developed to help patients manage their chronic diseases, but often these systems suffer from reduced use over time or complete abandonment. Limited research has been conducted that examines continued usage in this domain. Through this study, our purpose is to build and evaluate a mobile/web based JD monitoring system combined with a rewards program designed to increase continued system use. We propose a comprehensive continuance intention model by combining the IS Continuance Model proposed by Bhattacherjee with DeLone and McLean's IS Success Model. We also explore the role of the context specific constructs of Interaction Quality and Perceived Disease Management Effort and the moderating role of several individual factors on relations in the proposed model. We propose a longitudinal study utilizing a survey methodology to empirically validate the proposed model. Data analysis will utilize structural equation modeling using partial least squares. Participants in this survey consist of adolescent JD patients and their parents, allowing us to understand the factors which are most relevant to each stakeholder group.

Keywords: IS Success Model, IS Continuance, Mobile, Juvenile Diabetes, Loyalty Incentives, Interaction Quality, Self-Management, Satisfaction

1. INTRODUCTION

It is estimated that approximately 200 children per day worldwide develop JD ("Juvenile Diabetes Research Foundation," 2009). The risk of developing JD is higher than any other severe chronic childhood disease (Brown, et al., 1997) and the highest rates of JD are found in early adolescents (Anderson, et al., 2002). There is no cure for JD, therefore the focus is on controlling the disease to reduce urgent care visits and long term complications (Brown, et al., 1997; Hanauer, et al., 2009). It has been found to be more effective from a clinical, social and economic basis to support self-management of chronic diseases such as JD than utilizing hospitals or clinics for care (Medvedev, et al., 2008). In some countries it has been estimated that 70-80% of chronic disease patients are good candidates for self-management (Marshall, et al., 2007). Thus, the Juvenile Diabetes Research Foundation supports research that examines JD control via advanced monitoring tools.

The onset and diagnosis of JD typically occurs in childhood (Kaufman, 2009). For the purposes of this study, we will consider adolescence to begin at the age of 12, an age used in other diabetes related studies (Drummond, et al., 2003) and the end of adolescence to be 18. Typically, adolescents with JD suffer from low self-esteem (Lieberman, 2001) and have to manage their disease along with their growing social and development needs (Hanauer, et al., 2009). They are resistant to lifestyle restrictions and deviation from peer group norms (Brown, et al., 1997) that typically accompany JD, and exhibit high rates of noncompliance with monitoring and treatment (Lasecki, et al., 2008). It has been found that adolescents have more problems with diabetes management than younger children or adults have (Hanna, et al., 2003). The first few years after diagnosis with JD are critical (Anderson, et al., 2002), and it has been found that adherence to monitoring and treatment deteriorates as the duration of the disease progresses (Anderson, et al., 2002).

The National Initiative for Children's Healthcare Quality (NICHQ) has developed a Care Model for Child Health based on Wagner's (2001) Chronic Care Model. Two key elements of the Child Care Model are Self-Management Support and Family-Management Support (Wright, et al., 2001), both of which are key concepts of our study. It has been shown that adolescent JD patients must assume more responsibilities than their peers do (Carroll, et al., 2007), and that adolescents who are more independent and control the decision making process experience improved JD self-management (Hanna, et al., 2003). Unfortunately, there is often an unsuccessful transfer of control from parents to adolescents, resulting in poor diabetes management (Hanna, et al., 2003). Hence, there is a focus on empowering patients to control their diabetes condition (Mathews, et al., 2007; Mirza, et al., 2008).

Because of the age of the adolescent JD patient, managing the disease becomes a joint effort between the adolescent, their parent/legal guardian (note: we will use parent only for the remainder of this paper to refer to both parents and legal guardians) and their healthcare professional. During this age period, the management of the disease is a joint responsibility requiring high levels of communication and interaction between the adolescent and parent as adolescents and parents face rigorous processes in monitoring and controlling blood glucose levels (BGL) (Gammon, et al., 2005). The challenges of parenting are compounded when children have chronic disease (Gammon, et al., 2005), and many adolescents react negatively towards parental control (Brown, et al., 1997), further exacerbating the issues of JD. The growing influence of peers and a shift away from parental control contribute to poor disease self-management (Carroll, et al., 2007). At the same time, there is a lack of involvement of patients and families working together towards chronic disease management (Morgan, et al., 2007).

From a mobile perspective, adolescent patients raised with mobile technologies are likely to adopt mobile tools (Kumar, et al., 2004). Adolescents use mobile applications to build and strengthen relationships (Kaare, et al., 2007) as they can facilitate communication anytime, anywhere (Kaare, et al., 2007). From an adolescent diabetic perspective however, they want the mobile diabetes management technology to be 'cool' and similar to mobile devices their peers use (Carroll, et al., 2007). Recently, there have been several studies conducted that utilize mobile and web applications to assist in managing chronic diseases such as JD, as mobile applications allow for ubiquitous usage, and a majority of the population have access to mobile phones (Marshall, et al., 2007). In a recent paper it

was noted that 11 out of 23 mobile phone related chronic disease studies dealt specifically with diabetes or asthma (Skinner & Finkelstein, 2008), two of the most common chronic conditions. The potential of using mobile phones for diabetes self-management is becoming recognized (Wangberg, et al., 2006), with mobile applications being seen as a portable, accepted and inexpensive way to engage adolescents in diabetes self-management (Hanauer, et al., 2009). Mobile monitoring systems have been shown to assist in the transfer of disease management control from healthcare professional to chronic patients who engage in self-management, and there is a specific role for mobile applications as adolescents learn to assume control for their chronic condition (Pinnock, et al., 2007). It has been found that combinations of mobile technology with clinical devices for seamless measurement provide patient benefits (Thomson, et al., 2007), and that the reach and convenience of mobile technology enhances connectivity and monitoring (Thomson, et al., 2007) for chronic care patients. Some researchers argue that telemedicine solutions are key (Thomson, et al., 2007) for diabetes care.

Information systems (IS) have previously been utilized to improve blood glucose monitoring and adherence to insulin injection schedules. In spite of the availability and initial adoption of such systems, applications may been abandoned or experience a reduction in usage (Anhoj & Moldrup, 2004). Patients may give up on monitoring regimens that don't fit into their daily lives (Fonseca, et al., 2006). The technology used for such applications can also lead to abandonment issues, with internet only interventions suffering from attrition while a combination of mobile and web based was found to be more appealing (Anhoj & Moldrup, 2004). The lack of rewards offered for participation can lead to abandonment, with the need for more data on how adolescents perceive motivational factors (Lasecki, et al., 2008). Hence, mobile applications may need to provide adolescents the opportunity to determine the type of rewards offered (Lasecki, et al., 2008) in order to reduce abandonment and increase continuance.

Therefore, while IS has been shown to help, continuance is a problem and motivational factors have been suggested as a way to improve this situation. However, no known research has been conducted in this area. The proposed study attempts to fill this gap by designing and building an IS, specifically a mobile and web technology based Juvenile Diabetes Management System (JDMS) and then evaluating it through a comprehensive theoretical model of continuance intention which also incorporates the role of loyalty incentives. The remainder of this paper is organized as follows: the theoretical background and proposed research model are presented in section 2. The proposed research methodology is presented in section 3. Finally, contributions of this research to academics, practitioners and society are presented in section 4.

2. THEORETICAL BACKGROUND AND RESEARCH MODEL

The IS Continuance (Bhattacherjee, 2001b) and DeLone and McLean (D&M) (DeLone & McLean, 2003) IS Success models are used as the foundation for the proposed research model shown below. Previous adoption studies have been conducted that show chronic disease management aids are successfully adopted, yet later abandoned (Anhoj & Moldrup, 2004). Therefore, the concept of continued usage is of paramount importance to ensure that the JDMS experiences use on an ongoing basis. The IS continuance model has been successfully used to explain the factors leading to continued use of IS in areas such as e-commerce, e-learning, online banking, and healthcare (Bhattacherjee, 2001a, 2001b; Brown & Jayakody, 2008; Limayem & Cheung, 2008; Paré, et al., 2005). While the focus of this study is on the continued use intention of the proposed JDMS, continued usage requires the IS to be actually used and achieve user satisfaction. The D&M IS success model has been extensively used to examine the factors which lead to actual use and user satisfaction as well as perceived usefulness (net benefits) of an IS (Petter, et al., 2008; Petter & McLean, 2009; Sabherwal, et al., 2006). Hence, we incorporate relevant elements from the D&M model in our proposed model. By combining the D&M IS Success model with the IS Continuance model, we gain more insights into system-related factors that influence continuance. Finally, there are constructs which are specific to the use of an IS in managing chronic diseases in general and adolescent JD in particular. Accordingly, we have complemented the D&M model by adding Interaction Quality to the traditional Information

and System Quality constructs. We also introduce the construct of Perceived Disease Management Effort which is explained in greater detail in section 3. By adding these constructs, we ensure that we are capturing the most salient factors that lead to satisfaction and use of the JDMS. Since managing adolescent JD is a joint responsibility between adolescents and their parents, the success and continued use of a JDMS is dependent on two sets of users (i.e. adolescents and parents), and therefore 'user' in the hypotheses refers to adolescents/parents. The proposed research model is shown in Figure 1.

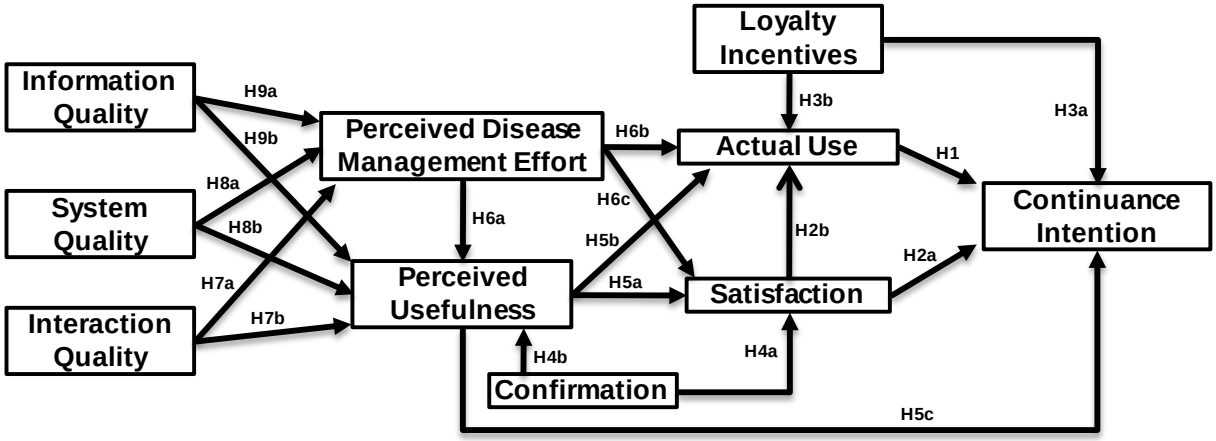

Figure 1: Proposed Research Model

Continuance Intention is defined as "users' intention to continue using [the IS]" (Bhattacherjee, 2001b). Continuance intention is extremely important to this study, as we seek to determine which factors will encourage adolescents to continue using the JDMS. A number of antecedent constructs are hypothesized to be positively related to continuance intention as detailed below.

Actual Use: IS continuance theory indicates that "confirmation is a cognitive belief (the extent to which users' expectation of IS use is realized during actual use) derived from prior IS use. In addition, it influences subsequent IS use via the satisfaction (affect) and intention constructs." (Bhattacherjee, 2001b). Most IS continuance studies do not overtly include the construct of actual use, but it can be inferred that actual use is an integral part of the theory, as confirmation cannot happen unless the IS is actually used. In a recent paper, Atchariyachanvanich et al. (2007) found a significant relationship between actual purchase and intention to repurchase in an online shopping environment, similar to actual use and continuance intention in our context. Thus we hypothesize that:

H1 – Increased actual use of the JDMS will positively influence users' intentions to continue using the JDMS

Satisfaction can be defined as a users' post-acceptance affect, recorded as positive (satisfied), indifferent, or negative (dissatisfied) (Bhattacherjee, 2001b). Previous research has shown satisfaction to have a significant positive effect on continuance intention (Bhattacherjee, 2001a, 2001b; Bhattacherjee, et al., 2008; Brown & Jayakody, 2008; Liao, et al., 2009; Roca, et al., 2006). Research that confirms this relationship has been significant in areas such as e-commerce, e-learning and online banking. We argue that users who are satisfied with the JDMS will be more likely to actually use the system during the study, and also exhibit stronger intentions to continue using the system in the future. Specifically, we hypothesize that:

H2a – Increased users' satisfaction with the JDMS will positively influence their intention to continue using the JDMS

H2b – Increased users' satisfaction with the JDMS will positively influence their actual use of the JDMS

Loyalty Incentives are used in a variety of areas and are designed to motivate continued purchases of products or services. Limited research has been done on the role of loyalty incentives in motivating

the initial adoption and continued use of an IS, and to date loyalty incentives have not shown to have a direct significant relationship on continuance intention. Studies by Bhattacherjee (2001a) and Brown & Jayakody (2008) have not found significant relationships between loyalty incentives and continuance intention, although Bhattacherjee found that loyalty incentives did have a significant relationship with continuance intention provided that the user found the system useful (Bhattacherjee, 2001a). Both of these studies examined loyalty incentives in an e-commerce context, with the intent of retaining customers through loyalty incentives, and where the switching costs for users are considered relatively low. Our study, on the other hand, is utilizing loyalty incentives to encourage users to increase actual use of the system and continue using the system in the future, and the potential of switching is minimal. Various studies have shown that diabetic patients playing a motivational game achieved better results in self-maintenance (Kumar, et al., 2004), higher levels of satisfaction (both parents and children) among group that played a diabetes related game versus non-game playing group (Kumar, et al., 2004), and improved self-care and reduction in emergency clinical intervention through the use of diabetes related video games (Lieberman, 2001). We can consider these motivational games to be similar to our concept of loyalty incentives, as they provide a means to motivate the adolescent to make greater use of the JDMS. Therefore, we argue that the provision of loyalty incentives to adolescents will encourage them to use the JDMS more often, and adhere to their schedule of BGL monitoring. Additionally, given the inclusion of loyalty incentives, adolescents might want to continue using the system in the future to maintain a steady stream of rewards. Specifically, we hypothesize that:

H3a – Inclusion of loyalty incentives (for adolescents) will positively influence their intention to continue using the JDMS

H3b – Inclusion of loyalty incentives (for adolescents) will increase their actual use of the JDMS

Confirmation is defined as "users' perception of the congruence between expectation of [IS] use and its actual performance" (Bhattacherjee, 2001b). It is the confirmation (or disconfirmation) of the expectations that users have regarding the system that has a relationship with how they view the usefulness of and satisfaction with the system. Confirmation is a key construct in IS Continuance theory, and has been shown to have significant relationships with both Satisfaction and Perceived Usefulness (Bhattacherjee, 2001a, 2001b; Bhattacherjee, et al., 2008; Roca, et al., 2006). In the context of our study, users will have some expectations of how useful the JDMS will be in helping the management of the disease and therefore we argue that if those expectations are met or exceeded, users will be satisfied with the JDMS and view the JDMS as being useful. Specifically we hypothesize that:

H4a – A higher level of confirmation of JDMS users' expectations will positively influence their satisfaction with the JDMS

H4b – A higher level of confirmation of JDMS users' expectations will positively influence their perceived usefulness of the JDMS

Perceived Usefulness can be defined as "users' perceptions of the expected benefits of [IS] use" (Bhattacherjee, 2001b). Perceived usefulness is one of the most studied constructs in IS, and in some ways is the 'glue' that holds together the two models we have combined in this study. In the D&M model, perceived usefulness is represented by net benefits (Petter, et al., 2008). Previous research supports significant relationships between net benefits and actual use (Petter, et al., 2008). In addition to the Petter et al. (2008) analysis, which found strong support for the relationship between net benefits (and thus perceived usefulness) and user satisfaction, Roca et al. (2006) found a significant relationship between perceived usefulness and satisfaction in an e-learning environment. In the IS continuance model, the relationships between perceived usefulness and satisfaction is supported by Bhattacherjee (2001b), while the relationship between perceived usefulness and continuance intention is supported by a number of studies (Bhattacherjee, 2001a, 2001b; Brown & Jayakody, 2008; Liao, et al., 2009). Therefore we argue that adolescents and parents who believe that the JDMS is useful will make greater use of the system, be more satisfied with the system, and be more likely to continue using the system in the future. Specifically, we hypothesize that:

H5a – A higher level of perceived usefulness of the JDMS will positively influence user satisfaction with the JDMS

H5b – A higher level of perceived usefulness of the JDMS will positively influence actual use of the JDMS

H5c – A higher level of perceived usefulness of the JDMS will positively influence intention to continue using the JDMS

Perceived Disease Management Effort is a new construct, and can be defined as the perceived physical effort (time, etc.) and psychological effort (mental concentration, emotional stress, etc.) required to manage the disease. The efforts required in managing JD can be overwhelming, with BGL monitoring and recording, insulin injections and frequent parent child communication. One of the main advantages of using a JDMS is to reduce this disease management effort, as the JDMS provides reminders to take their BGL readings, allows the JD patient to enter their BGL from wherever they are, provides quick and easy to read information regarding their disease management progress, and automatically communicates results to their parents. Therefore, we argue that a reduction in the efforts required in managing JD due to use of the JDMS will result in users viewing the JDMS as being more useful; an increase in the actual use of the JDMS; and greater satisfaction with the JDMS. Specifically we hypothesize that:

H6a – A lower level of perceived disease management effort will positively influence perceived usefulness of the JDMS

H6b – A lower level of perceived disease management effort will positively influence actual use of the JDMS

H6c – A lower level of perceived disease management effort will positively influence satisfaction with the JDMS

Interaction Quality refers to the quality of parent-adolescent interaction and healthcare professional-adolescent interaction. From a chronic disease perspective, parents report a need for information (Wangberg, et al., 2006), and report worrying about long term complications when adolescents don't perform proper self-management (Carroll, et al., 2007). Constant vigilance is a strategy often taken by parents (Gammon, et al., 2005), and a need to see a reduction in parental hyper vigilance has been indicated (Carroll, et al., 2007). Parent-child conflict has been shown to be negatively correlated with adherence and BGL control (Anderson, et al., 2002; Hanna, et al., 2003; Miller-Johnson, et al., 1994) while appropriate parental involvement was shown to be associated with positive diabetes outcomes (Anderson, et al., 2002; Gammon, et al., 2005). Using mobile technology in a JDMS can lead to more effective communication with parents regarding JD self-care (Carroll, et al., 2007) and can help with the 'fine line' between helping children and nagging them (Carroll, et al., 2007). It is important to note that it is the quality and not the quantity of interaction that is important, and that in many cases, a reduction in the quantity of interaction will be viewed as an increase in the quality of interaction (e.g., less parental intrusion in the life of the adolescent, etc. as noted by Carroll et al. (2007)). There was no research we could find that was specific to parent-adolescent interaction in an IS or a healthcare setting. However, a study by Wang et al. (2005) examines interaction quality from an IS user and IS professional perspective, which has similarities to a adolescent-parent and adolescent-healthcare professional context. This study found a significant relationship between interaction quality and project performance. We argue that the more positively users view the quality of interaction with each other and potentially with healthcare professionals, the less the perceived effort required for disease management will be. In addition, the more positively users view the quality of interaction with each other and potentially with healthcare professionals, the more positively they will perceive the usefulness of the system. Specifically, we hypothesize that:

H7a – Higher perceptions of interaction quality due to using a JDMS will negatively influence perceived disease management effort

H7b – Higher perceptions of interaction quality due to using a JDMS will positively influence perceived usefulness of the JDMS

System Quality is often measured using perceived ease of use, but other factors such as "reliability, portability, user friendliness, understandability, effectiveness, maintainability, economy, and verifiability" (Petter, et al., 2008) are used as well. A vast amount of research has found significant relationships between system quality and satisfaction with IS (Petter, et al., 2008; Petter & McLean, 2009; Roca, et al., 2006), use of and intention to use an IS (Petter & McLean, 2009). A study by Sabherwal et al. (2006) showed a significant relationship between system quality and perceived usefulness. Petter et al. (2008) indicate that at the individual level, the most common measure of net benefits in the D&M model is perceived usefulness. Studies summarized by Petter et al. (2008) have shown good support for the relationship between system quality and net benefits, and therefore with perceived usefulness. Similarly, better system quality will make the tasks involved in managing the disease easier and thus adolescents and parents will view this as reducing their efforts in managing the disease. Thus, we hypothesize that:

H8a – Higher perceptions of JDMS system quality will negatively influence perceived disease management effort

H8b – Higher perceptions of JDMS system quality will positively influence perceived usefulness of the JDMS

Information Quality "refers to quality of the output, such as timeliness, scope, relevance, and accuracy of information generated by an information system" (Roca, et al., 2006). In the context of JDMS, information quality refers to quality of the information JD patients can access to help them successfully manage their disease, such as alerts to perform BGL and graphs/charts which allow them to see their disease management progress. Similar to system quality, a large amount of research has found significant relationships between system quality and satisfaction with IS (Petter, et al., 2008; Petter & McLean, 2009; Roca, et al., 2006), use of and intention to use an IS (Petter & McLean, 2009). Studies summarized by Petter et al. (2008) have shown good support for the relationship between information quality and net benefits, and therefore we can support the relationship at the individual level for the relationship between information quality and perceived usefulness. Brown and Jayakody (2008) found a significant relationship between information quality and perceived usefulness in an e-commerce setting. Therefore we argue that better information quality will lead both adolescents and parents to view the JDMS as being more useful. Similarly, better information quality will make the tasks involved in managing the disease easier and thus adolescents and parents will view this as reducing their efforts in managing the disease. Specifically, we hypothesize that:

H9a – Higher perceptions of JDMS Information quality will negatively influence perceived disease management efforts

H9b – Higher perceptions of JDMS Information quality will positively influence perceived usefulness of the JDMS

In addition, we will examine the effects that moderating variables (e.g., age, gender, age at onset, disease severity, and socio-economic status) have in our model. This examination is supported by Cooper et al. (2009) who noted a need to examine other factors such as time since diagnosis, ethnic and socio-economic differences when exploring the effectiveness of an information and communication technology for young people living with diabetes.

3. RESEARCH METHODOLOGY

Research Setting: The proposed JDMS we will build and study involves the basic mobile technology of Short Message Service (SMS) that participants will utilize to transmit their BGL measurements to a central server, which will in turn share the results (or at a minimum confirmation that measurements have been entered) with the parents of the adolescent, and if desired with a healthcare professional's

office. In one study, 90% of parents and children were in favour of making BGL results available for other authorized parties to review (Hanauer, et al., 2006). The BGL measurements will either be entered into the mobile phone by the adolescent, or if available be transmitted directly from a BGL meter with wireless Bluetooth capabilities. If desired, the JDMS can send alerts/reminders to the adolescent with respect to their BGL monitoring. Measurement history will be stored in a secure data repository and made available to the participants through secure, password protected web pages that will allow adolescents, parents and healthcare professionals to access raw data and interactive graphs and charts to see the progress of the adolescent. In addition, reward points will be awarded to the adolescent participant based on the frequency of results entered as well as the adherence to a preset schedule of times (decided jointly between the adolescent and parent under the guidance of a healthcare professional) that measurements are to be taken. These reward points can be used by the adolescent to purchase items from an online rewards catalogue, with choices such as downloadable ring-tones, songs from iTunes, etc. The study will provide the loyalty incentives to one-half of the adolescent participants, allowing us to understand the effect that loyalty incentives has in our model.

Pilot Study: The purpose of the pilot study is to evaluate the proposed JDMS, gather insights on the feasibility of the system and how it would be used in the participant's daily lives, identify any required changes to the functionality of the JDMS and the rewards that are being offered, identify any confusion with the survey instrument and make any necessary final adjustments to the proposed research model. The pilot study will begin with the development of the JDMS discussed above. Once this JDMS has been developed, a pilot study of 10 adolescent-parent pairs will be run for approximately one month. Both adolescent patients and parents will be trained in the use of the JDMS at this time, and all adolescent participants will require parental consent to use the JDMS for the duration of the pilot study. At the end of the study participants will be asked to fill a survey containing the model measures as well as demographic and other variables of interest to our study (e.g. disease severity, age at JD onset, socio-economic status). In-person interviews will also be conducted at the conclusion of the pilot study to debrief participants about their experiences in using the JDMS. Ethics approval for the pilot study will be secured prior to the initiation of this phase.

Main Study: In the main phase of the proposed research, a larger scale assessment of the proposed JDMS will be completed over a period of six months. A total of 150 participating adolescent-parent teams will be recruited to participate in this study. Participants will be recruited from diabetes clinics over the course of three months (JD patients typically see their endocrinologist/clinic once every three months, and therefore, we can recruit from the entire population of clinic patients). Surveys will be completed by the parent prior to the beginning of the study (to gather necessary demographic, health and socio-economic data) and both adolescents and parents will complete the final survey administered at the conclusion of the main phase of the study. Only one parent will be required to complete this final survey, with an expectation that this be the parent who has had the highest utilization of the JDMS and primary responsibility for the adolescent from a disease management and interaction perspective. For ease of implementation, web-based questionnaires will be employed which fits well with the technology approach of this study. In addition to collecting responses for our construct measures, we will also include open-ended questions relating to participant experiences using the JDMS as well as their perceptions of how the JDMS affected the parent-adolescent interaction and contributed to a change in perceived disease management effort. The responses to the open-ended questions will be analyzed to strengthen the empirical findings through triangulation (Benbasat, et al., 1987). All required ethics approvals will be secured prior to the initiation of the main phase.

Model Validation: To validate the model we will utilize Structural Equation Modeling (SEM) as it allows the simultaneous modeling of independent and dependent constructs and "the intricate causal networks enabled by SEM characterize real-world processes better than simple correlation-based models" (Gefen, et al., 2000). Specifically, we will use Partial Least Squares (PLS) as it supports confirmatory and exploratory research as well as both reflective and formative constructs (Gefen, et al., 2000). Based on Gefen et al. (2000), a thorough analysis of the measurement model will be performed through item loadings, internal consistency and discriminant validity.

Measurement Instruments: Wherever possible, previously developed measurement scales will be utilized in this study. Interaction quality will be measured using a 4-item scale by Wang et al. (2005). Perceived usefulness will be measured using an 11-item scale by Lankton and Louis (2005). This measurement scale is highly relevant to our study, as it measures perceived usefulness of an interactive health communication system in the context of diabetes. Information quality will be measured using an 9-item scale by Roca et al. (2006), system quality will be measured using an 8-item scale developed by Seddon and Kiew (1994); Confirmation and continuance intention will be measured using 3-item scales by Bhattacherjee (2001b); Satisfaction will be measured using four semantic differential adjective pairs from Bhattacherjee (2001b). Actual use will utilize a composite measure of both mobile and web system usage. Because this study will record all BGL measurements sent via SMS to the central server, and logs of which web pages (and therefore which web functionality) are utilized by both adolescents and parents, we are able to measure actual use of the system, rather than intention to use. The composite measures that will be included in the actual use construct are: (i) BGL reading frequency; (ii) adherence to predetermined BGL monitoring schedule; (iii) frequency of web usage, and; (iv) percentage of available web functionality utilized. Perceived Disease Management Effort is a new construct that will require the development a new measurement scale by following the item creation, scale development and instrument testing guidelines set forth by Moore & Benbasat (1991). The items for this construct will include elements to capture the physical and psychological efforts required from adolescents and their parents to manage their disease. Finally, Loyalty Incentives will simply be measured as a 0 or 1 dummy variable, depending on whether or not the adolescent was part of the group that received incentives. Dummy variables have been previously utilized in PLS models, as in (Venkatesh & Morris, 2000).

Individual Characteristic Impact: To adequately assess the impacts of individual characteristics on JDMS usage, we will employ the required statistical techniques. First, to examine the differences between adolescents and parents perceptions, separate regression models will be developed for each group and subsequently analyzed and compared using Chow's (1960) test to elicit any significant variations in the model. Second, we will examine between-group differences in terms of model relations for parents and adolescents following the Qureshi & Compeau (2009) methodology. Third, we will examine the impacts of age, gender, age at onset, disease severity, and socio-economic status by developing a set of control models. This will be done by adding each control variable (one at a time) as a construct to the existing model and comparing the variance explained in the original model to the new control models to determine the role of each of the individual factors. Finally, as per Gefen at al. (2000), we will use PLS to examine any possible interaction effects between the independent variables in the proposed model.

Sample: Sample sizes when using PLS are determined by the larger of 10 times the largest number of paths leading to a construct or 10 times the largest number of items in any one construct (Chin, 1997). Given that the Perceived Usefulness construct in our model has 11 items, a sample size of 110 will be required for this study. However, due to the possibility of participants withdrawing from the study and to accommodate the potential for spoiled surveys, we propose recruiting approximately 150 participant pairs (i.e., adolescents and parents).

4. POTENTIAL CONTRIBUTIONS

This study will contribute to theory in a variety of ways. First, we are combining two established theories (D&M IS Success and IS Continuance) in a healthcare setting. Therefore, we have designed a more comprehensive model to examine not only what makes a JDMS successful but also the requisite elements that ensure its continued usage. Second, we are adding the Loyalty Incentives construct to the IS Continuance portion of the model to understand the relationships with Actual Use and Continuance Intention. Third, we have also added a construct to the D&M model, namely Interaction Quality, an element that is extremely important in adolescent management of JD. Fourth, we will also develop the new construct of Perceived Disease Management Effort, which encompasses the physical, emotional and mental efforts required on behalf of adolescents and their parents to manage the JD.

Fifth, while the focus of this study is on JD and adolescents, the results of this study will be generalizable to adolescents with other types of chronic conditions, and also individuals from all age groups who suffer from chronic diseases. Finally, because we measure actual use of the system, we are able to analyze the actual impacts of the system on managing the adolescents JD.

The study will contribute to practitioners in two highly relevant ways. First, we will discover the factors that influence satisfaction with and the continued use of JDMS, allowing practitioners to understand the relative importance of the various factors to adolescents and their parents. This will allow developers of disease self-management systems to design optimized systems for JD in particular and chronic diseases in general. Additionally, we will determine the importance of loyalty incentives in disease self-management situations, allowing practitioners to determine whether they should offer incentives as part of the disease self-management program.

The social contribution of this study is highly relevant. The overarching purpose of this study is to enhance BGL monitoring and control for adolescents to improve their health situation and quality of life. While adolescents may not think about long term health implications, this study does. By improving monitoring and control techniques today, JD patients should see a reduction in future healthcare professional and hospital visits, a decrease in longer term health complications and potentially increased life expectancy. Additionally, a reduction in health care visits and health complications will reduce the burden on the healthcare system and thus provide benefits to society.

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