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Contents

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Feasibility of Two Educational Methods for Teaching New Mothers: A Pilot Study

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Abstract

Background: Printed health educational materials are commonly issued to prepare patients for hospital discharge. Teaching methods that engage multiple senses have been shown to positively affect learning outcomes, suggesting that paper materials may not be the most effective approach when educating new mothers. In addition, many written patient educational materials do not meet national health literacy guidelines. Videos that stimulate visual and auditory senses provide an alternative, potentially more effective, strategy for delivering health information. The acceptability of these methods, as perceived by nurses executing patient education initiatives, is important for determining the most appropriate strategy.

Objective: The purpose of this study was to determine the feasibility of 2 educational methods for teaching new mothers how to care for themselves and their infants after hospital discharge. Feasibility was measured by adequate enrollment, acceptability of the intervention to patients and nurses, and initial efficacy.

Methods: New mothers (n=98) on a Mother-Baby Unit received health information focused on self-care and infant care delivered as either simple printed materials or YouTube videos on an iPad. Mothers completed a pretest, post-test, and an acceptability survey. Following completion of the initiative, nurses who participated in delivering the health education using one of these 2 methods were asked to complete a survey to determine their satisfaction with and confidence in using the materials.

Results: Mothers, on average, were 26 years old; 72% had a high school education; and 41% were African American. The improvement in knowledge scores was significantly higher for the iPad group (8.6% vs 4.4%, P=.02) compared to the pamphlet group. Group (B=4.81, P=.36) and time (B=6.12, P<.001) significantly affected scores, while no significant interaction effect was observed (B=5.69, P=.09). There were no significant differences in responses between the groups (all P values >.05). The nurses had a mean age of 44.3 years (SD 13.9) and had, on average, 16.6 years of experience (SD 13.8). The nurses felt confident and satisfied administering both educational modalities.

Conclusions: The pamphlet and iPad were identified as feasible and acceptable modalities for educating new mothers about self-care and infant care, though the iPad was more effective in improving knowledge. Understanding the acceptability of different teaching methods to patient educators is important for successful delivery of informational materials at discharge.

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KEYWORDS

Patient Education as Topic; Video Recording; Postpartum Period; Utilization; Nurses; Personal Satisfaction

Introduction

Background

International health care providers have long acknowledged the importance of sharing health information with patients/consumers. In no population group is education more important than childbearing women and their families [1]. The World Health Organization recommends that essential health content be taught to pregnant and parenting women to protect their health and that of their babies (eg, postnatal recovery, care of the newborn, promotion of early exclusive breastfeeding, and assistance with deciding on future pregnancies to improve pregnancy outcomes) [1]. However, childbearing women frequently have difficulty interpreting and operationalizing information, and health education may not translate into appropriate health behaviors [2].

In the United States, emphasis on health education for all patient groups is unprecedented. The Affordable Care Act encourages patients to take control of their health care decisions based upon the latest evidence [3]. In the acute care setting, national organizations such as the Agency for Healthcare Research and Quality, American Medical Association, Centers for Medicare and Medicaid Services, and Patient-Centered Outcomes Research Institute stress the need for effective health education for hospitalized patients and an evaluation of health education is included in hospital accreditation procedures [4]. Soon, reimbursement to acute care settings will be based upon such quality measures.

Testing innovative methods for teaching new mothers, with attention to health literacy levels of the population, should be guided by efforts to improve state maternal child health statistics [5-7]. Kentucky has one of the lowest literacy rates in the United States with 14% of adults 16-65 years of age, on average, having very little to no literacy skills and another 26% having low literacy skills [8]. Simultaneously, the rate of substantiated cases of child abuse in Kentucky is 16.6 per 1000 children, compared to the US rate of 9.1 in 2011 [9]. Traumatic brain injury is the leading cause of death for children and 64% of cases are from abuse [10]. The US has a higher rate of fatalities from child abuse and neglect than any other higher income country and Kentucky has ranked among the states with the highest rate over recent years [11]. Kentucky is currently ranked 8th among all states for child abuse fatalities [11]. Breastfeeding statistics from Kentucky are also poorer than the US average for all indicators including rates of ever breastfeeding (United States 77% vs Kentucky 59%), breastfeeding at 6 months (47% vs 27%), breastfeeding at 12 months (26% vs 11%), exclusive breastfeeding at 3 months (36% vs 21%), and exclusive breastfeeding at 6 months (16% vs 10%) [12]. Rates of postpartum depression, which have an adverse impact on development of both the mother and infant, are greater than or equal to national rates in Kentucky. Poverty is a risk factor for all of these and many other threats to women and children's health [13-19]. These data suggest that innovative methods for teaching new mothers, with attention to health literacy levels of the population, are needed if we are to improve state statistics and address health issues that are frequently associated with poverty in women and children.

In Kentucky, like the remainder of the United States, most women deliver their newborns in hospitals and are discharged from the hospital 2-3 days after birth. In hospitals, most health education has traditionally consisted of providing verbal instruction and written health education materials before hospital discharge, but the efficacy and acceptability of these methods have not been comprehensively evaluated. In 2005, the Center for Medicare and Medicaid Services developed a standardized survey, the Hospital Consumer Assessment of Healthcare and Systems, to measure patients' perspectives on the quality of hospital stays. The survey is administered by outside companies and includes questions about communication with nurses and discharge education.

Key to effective patient education is tailoring materials and messages to appropriate literacy levels and preferred learning styles of patients [20,21], especially in families who are at risk for adverse outcomes due to low education and/or low literacy levels. Additionally important is teachers' satisfaction with, and confidence in, using methods and materials when educating new mothers and families [22]. The purpose of this study was to determine the feasibility of 2 educational methods for teaching new mothers how to care for themselves and their infants after hospital discharge. Feasibility was measured by adequate enrollment, acceptability of the intervention to patients and nurses, and initial efficacy as described in a tutorial on pilot studies by Thabane et al [23].

Review of the Literature

Written educational materials are widely used at hospital discharge but may not be the most effective vehicle for educating today's generation of new mothers [20,24,25]. Teaching that engages multiple senses has been shown to enhance learning [26,27]. For example, it has long been known that videotapes can portray real-life situations; employ actors, graphics, and words that are appropriate for a particular population; improve short-term knowledge [27]; and enhance retention of information better than written materials [28]. Research on dual coding theory has determined that when individuals both see and hear an explanation, they are able to generate more creative solutions to solve problems [26]. Dual coding theory assumes that there are 2 cognitive subsystems: one processes nonverbal events (imagery) and the other specializes in language. New technology that includes video and engages 2 cognitive subsystems provides an alternative, and potentially more effective, way to deliver health information [29].

Increasingly, pregnant and parenting women are using technology to access health information [30]. In a recent US survey (Listening to Mothers III), nearly two thirds (64%) of pregnant or parenting women accessed online health information from a mobile phone in a typical week and 82% went on the

Internet from a computer [31]. Women also reported using tablet devices (35%) and iPod Touch devices (21%) to access information on the Internet. Further testing is needed to determine which technology is most effective and acceptable. While some studies have shown that low-income individuals are less likely to access the Internet, it was concluded that decreasing literacy demands would increase accessibility and use of information [32,33].

New mothers are often overwhelmed with the amount of new information that they are given at hospital discharge. In order to enhance learning, it may be more effective to focus on essential topics that new mothers must know about self and baby care before they visit a health care provider 2-4 days after hospital discharge [34,35]. One essential topic is knowledge of breastfeeding [36].

Data from our maternity unit, the Center for Women and Infants at the University of Louisville Hospital (ULH), indicate there is room for improvement in our patient education. When asked whether nurses explained discharge information in a way that could be understood, 73.1% of mothers answered "Yes," which was below the national average of 78% [37]. In addition, our earlier research indicated that some of our written health education for new mothers had a reading level that was too high [38] and that new mothers are comfortable using technology to obtain health information [39]. Thus, our nursing staff were motivated to develop and test an intervention to improve patient education, prompting this study.

Methods

Study Design

During a specified period, all mothers on the Mother-Baby Unit were randomized to receive standard teaching or a newly developed teaching module as part of a quality improvement initiative, which included an evaluation component. Mothers were then asked if their data could be included in a research study. The study was approved by the site and the Institutional Review Board of the University.

Sample

Eligibility criteria included English-speaking mothers with live births, whose babies were not in the neonatal intensive care unit and were expected to be discharged with their birth mothers. Table 1 displays data related to demographics of the sample, for which there were no significant differences between the 2 groups (all *P* values >.05). A majority of the analytic sample were non-Hispanic white (n=39/98, 39.8%) or black (n=40/98, 40.8%) with a high school education (n=71/98, 72.4%) and a mean age of 26.2 years. All nurses on the Mother-Baby Unit who completed discharge teaching during the study period were asked to complete the nurse acceptability survey.

Table 1. Overall baseline demographics and stratified by educational modality.

Variable		Overall (n=98) n (%) or mean (SD)	Pamphlet (n=51) n (%) or mean (SD)	iPad (n=47) n (%) or mean (SD)	*P* value
Hispanic		5 (5.1)	2 (3.9)	3 (6.4)	.58
Ethnicity					
	White	39 (39.8)	22 (43.1)	17 (36.2)	.62
	Black	40 (40.8)	19 (37.3)	21 (44.7)	
	Other	15 (15.3)	9 (17.7)	6 (12.8)	
Education					
	<High school	22 (22.4)	10 (19.6)	12 (25.5)	.75
	High school	71 (72.4)	38 (74.5)	33 (70.2)	
	>High school	5 (5.1)	3 (5.9)	2 (4.2)	
Mean age		26.2 (6.1)	27.2 (6.4)	25.2 (5.6)	.10

Intervention

The study intervention was developed as follows. First, with guidance from the literature including the Baby Friendly Initiative [34-36], nursing staff and nursing leaders created a list of essential topics that new mothers must be taught before hospital discharge. Information was restricted to that needed by new mothers before their first pediatric office visit 2-3 days after discharge. Second, simple patient education brochures were developed on these topics, based upon national health literacy guidelines [40,41]. Third, the digital media services department of the university created short videos of the content and placed them on the YouTube channel. Fourth, nursing staff critiqued the pamphlets and videos. Minor revisions were made based upon this input. One hour of staff training was completed before initiation of the study. Finally, the YouTube channel was accessed through computer/tablets on the unit. Upon hospital discharge, new mothers were given information about how to access the YouTube channel if further clarification was needed.

Study Measures

Study measures included an investigator-created assessment of knowledge. Acceptability of the interventions was also measured in mothers and nurses.

Procedures

Using a table of random numbers, new mothers were randomized into the iPad or pamphlet conditions. After consenting to the study, mothers completed a pretest. After the intervention, they completed a post-test and acceptability survey. Nursing staff on the unit delivered the intervention. We examined the feasibility and acceptability of the 2 differing educational modalities in the new mothers by asking 9 questions, which are described in the "Results" section.

Upon completion of the patient intervention, all nurses on the unit who participated in the new discharge teaching were asked to complete a brief survey to determine their level of acceptance regarding using YouTube videos and iPads to educate postpartum patients. The survey examined nurses' perceived confidence and satisfaction in delivering the educational modalities through 5 questions, which are described in the "Results" section. The survey was distributed to nurses via email. Anonymous surveys were returned in an envelope to the unit and were picked up by the study team. A reminder email was sent twice before data collection was deemed complete.

Power and Sample Size Justification

For this study, all new mothers (live births) at ULH were considered. Based on our preliminary studies, we anticipated that 10% of all potential participants would not be eligible and/or willing to participate, and that 10% of the eligible/willing participants would be lost to follow-up. Therefore, we recruited 100 mothers (n=51 in the pamphlet group, and n=49 in the iPad group). This was a feasible sample size for the research team to recruit and enroll for the study. Two (2.0%) were lost to follow-up. All analyses were performed on data for the remaining 98 individuals (n=51 in the pamphlet group and n=47 in the iPad group). Power calculations were based on the anticipated total sample size (n=98) and were used for complete analysis. We developed separate mixed-effects general linear models for each of the outcomes. Based on the anticipated sample size, the study had 84% power to detect a 10% main effect of each treatment for each outcome. Therefore, the number of participants in each comparison group was more than sufficient.

Statistical Analysis

To determine the influence of the iPad versus simple pamphlet on knowledge of self-care and infant care, we started with straightforward tests for differences between the 2 groups of individuals. Independent samples *t* tests were used to test for differences among continuous variables, while chi-square Fischer exact tests and Wilcoxon methods (when appropriate) were used to test for differences among categorical variables. To examine outcome knowledge for self-care and infant care, separate mixed-effects general linear models were developed for each outcome. The educational modalities were analyzed as fixed effects, and time (week since randomization) was analyzed as a repeated measures effect. All main effects and two-way interaction effects were investigated for significance from the mixed-effects models that were developed. Data were collected from the YouTube channel to determine the frequency and duration of access after hospital discharge.

Results

Improvement in Outcomes Over Time

As seen in Table 2, the iPad group had lower mean outcome scores at baseline (81.7% vs 84.3%, *P*=.27), but the difference in mean scores was not significant. By contrast, the iPad group had higher scores at follow-up (90.3% vs 88.7%, *P*=.43), but still did not reach significance. However, the improvement in scores was significantly higher for the iPad group (8.7% vs 4.4%, *P*=.02) compared to the pamphlet group.

Table 2. Baseline scores, T2 scores, and change in scores over time stratified by group.

Variable	Pamphlet Mean (SD)	iPad Mean (SD)	*P* value
Baseline scores	84.3% (11.0%)	81.7% (12.5%)	.27
T2 Scores	88.7% (10.8%)	90.3% (9.9%)	.43
Change over time	4.4% (8.3%)	8.7% (9.3%)	.02

As seen in Table 3, taking a longitudinal approach, group (*B*=4.81, *P*=.36) and time (*B*=6.12, *P*<.001) significantly affected scores over time, while no significant interaction effect was observed (*B*=5.69, *P*=.09).

Table 3. General linear model: scores by group, time, and group by time interaction.

Predictor	*B* (95% CI)	*P* value
Group	4.81 (2.7-9.7)	.04
Time	6.12 (3.8-12.2)	<.001
Group-time interaction	5.69 (2.8, 13.0)	.09

Feasibility and Acceptability

Mothers

As seen in Table 4, new mothers found both the pamphlet and iPad to be feasible and acceptable modalities for receiving education about self-care and infant care. There were no significant differences in feasibility and acceptability responses between the 2 groups (all *P* values >.05).

Table 4. Feasibility and acceptability measures for participants overall and stratified by group.

Question	Overall (n=98) n (%)	Pamphlet (n=49) n (%)	iPad (n=45) n (%)	*P* value
Easy to read	89 (94.7)	48 (98.0)	41 (95.3)	.14
Good place for me to learn more about depression	88 (93.6)	48 (98.0)	40 (89.0)	.07
Good place for me to learn more about infant care	90 (95.7)	48 (98.0)	42 (93.3)	.27
Good place for me to learn more about building a bond with my baby	85 (90.4)	45 (91.8)	40 (89.0)	.63
Good place for me to learn more about breastfeeding	87 (92.6)	45 (91.8)	42 (93.3)	.78
Know where to call if I need help with my infant	87 (92.6)	47 (95.9)	40 (89.0)	.20
Know what to do if I need help	88 (93.6)	47 (95.9)	41 (95.3)	.34
Recommend	88 (93.6)	48 (98.0)	40 (89.0)	.07
I am more likely to get treatment if I have depression	85 (90.4)	44 (89.8)	41 (95.3)	.83

Nurses

The nurses felt confident and satisfied using both the iPad and simple pamphlets, as seen in Table 5. The nurses had a mean age of 44.3 years (SD 13.9) and had, on average, 16.6 years of experience (SD 13.8).

Table 5. Nurses' confidence and satisfaction scores for administering the education modalities.

Question	Mean score (SD)[a]
Confidence in having met the new mother's and family's need for teaching	5.94 (0.9)
Confidence in your use of the iPad and YouTube videos for teaching	5.06 (1.6)
Confidence in your use of simple pamphlets for teaching	6.00 (0.9)
Satisfaction with simple pamphlets	6.00 (1.1)
Satisfaction with iPad and YouTube	5.00 (1.7)

[a]Scores range from 1 (very low) to 7 (very high).

Follow-up Visits to YouTube

Mothers who received the iPad intervention were provided information on how to return to the YouTube Channel to view the videos after hospital discharge; 8 of 45 mothers did so. The topics viewed after discharge were the following: breastfeeding (n=1), bottle feeding (n=1), and critical symptoms in mothers (n=6).

Discussion

Principal Findings

The pamphlet and iPad were identified as feasible and acceptable modalities for educating new mothers about self-care and infant care. The nurses felt confident and satisfied administering both educational modalities.

Limitations

Limitations of the study include data collection from one organization, a cross-sectional design, and the use of investigator-developed questions. In addition, only English-speaking mothers and those with an infant being discharged home with them were included in the study. Our next study will address these limitations. In addition, the results may have been impacted by a ceiling effect, as both interventions were evaluated highly.

Comparison With Prior Work

In agreement with findings of other researchers [42], YouTube served as an effective method for sharing health information in this study. Further research should test the simultaneous use of written and creative video materials by health literacy level [43].

Conclusions

These findings provide a foundation to determine whether using the preferred teaching method from this study could improve long-term outcomes for women and their infants, and to examine the cost-effectiveness of delivering health information using technology. This study is in line with funding priorities of national organizations; both the Agency for Healthcare Research and Quality and Patient-Centered Outcomes Research Institute

have set priorities to reduce health disparities for those most at risk, such as low-income women and children from inner cities. Results from this study hold great promise for improving the uptake of information among new mothers with limited literacy skills, their health status and that of their baby, and their satisfaction with care [33].

Conflicts of Interest

None declared.

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Abbreviations

ULH: University of Louisville Hospital

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Original Paper

Third Molars on the Internet: A Guide for Assessing Information Quality and Readability

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Abstract

Background: Directing patients suffering from third molars (TMs) problems to high-quality online information is not only medically important, but also could enable better engagement in shared decision making.

Objectives: This study aimed to develop a scale that measures the scientific information quality (SIQ) for online information concerning wisdom tooth problems and to conduct a quality evaluation for online TMs resources. In addition, the study evaluated whether a specific piece of readability software (Readability Studio Professional 2012) might be reliable in measuring information comprehension, and explored predictors for the SIQ Scale.

Methods: A cross-sectional sample of websites was retrieved using certain keywords and phrases such as “impacted wisdom tooth problems” using 3 popular search engines. The retrieved websites (n=150) were filtered. The retained 50 websites were evaluated to assess their characteristics, usability, accessibility, trust, readability, SIQ, and their credibility using DISCERN and Health on the Net Code (HoNCode).

Results: Websites’ mean scale scores varied significantly across website affiliation groups such as governmental, commercial, and treatment provider bodies. The SIQ Scale had a good internal consistency (alpha=.85) and was significantly correlated with DISCERN (r=.82, P<.01) and HoNCode (r=.38, P<.01). Less than 25% of websites had SIQ scores above 75%. The mean readability grade (10.3, SD 1.9) was above the recommended level, and was significantly correlated with the Scientific Information Comprehension Scale (r=.45. P<.01), which provides evidence for convergent validity. Website affiliation and DISCERN were significantly associated with SIQ (P<.01) and explained 76% of the SIQ variance.

Conclusion: The developed SIQ Scale was found to demonstrate reliability and initial validity. Website affiliation, DISCERN, and HoNCode were significant predictors for the quality of scientific information. The Readability Studio software estimates were associated with scientific information comprehensiveness measures.

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KEYWORDS

DISCERN; health information online; Health on the Net Code; readability; Scientific Information Quality Scale; website affiliation; website content analysis; wisdom teeth

Introduction

Wisdom teeth removal is the most commonly performed oral surgical procedure [1]. In addition to patients needing to make a decision regarding whether or not to remove asymptomatic wisdom teeth [2,3], other decisions need to be made regarding anesthetics options, treatment pathways and associated costs, operation timing, and expected recovery [1]. Patients who undergo third molars (TMs) extraction prefer to receive detailed procedural information [4]. Providing those patients with detailed high-quality information is not only medically and legally important in making an informed decision, but also might improve their participation in the process of shared clinical decision making. This might, in turn, improve patient satisfaction and treatment outcomes [5].

It is not always possible to provide adequate information for patients suffering from TMs problems, because it might be limited by the available consultation time allocated to each patient, given the fact that clinics are often overbooked [6]. The busy nature of oral surgery clinics may hinder surgeons from adequately explaining the provided information, a finding suggested by Ferrús-Torres et al [7]. Lack of sufficient information from professional sources and limitations of information leaflets [8] can result in patients seeking online sources to satisfy their information demands and often before consultation [9]. While the Internet plays an increasing role in dental patient education [10], the quality of online health information varies significantly across websites [11,12]. Therefore, it is argued that clinicians should guide their patients to credible online health resources.

There can be a potential limitation in the current clinical practice in referring patients to high-quality Internet resources due to clinicians' lack of time and/or lack of knowledge [13,14]. In addition, the lack of dentists' ability to discuss the retrieved conflicting Internet-related information with their patients may affect the patient-dentist relationship [10]. To provide patients with guidance in navigating the Internet, clinicians could use the findings from website content analysis studies. However, only a small number of dentally related studies exist and none have covered wisdom tooth problems. The lack of content analysis studies means the absence of an evidence base with which clinicians might be able to guide their patients to credible Internet-based resources. Furthermore, identifying predictors for scientific information quality (SIQ) could make the process of identifying high-quality online resources easier and less time consuming. However, clinicians also need to ensure that the high-quality Internet resources they identify are understandable by their patients.

Understanding health information is a major domain in health literacy, allowing patients to make appropriate health-related decisions [15]. Patients with higher levels of health literacy have been found to have a better oral health status [16]. To ensure that consumer health information is understandable by the average patient, some health authorities require this information to be at Grade 8 reading level or less (13-14 years of age) [17]. Readability grades are calculated using different readability formulas [18] and are mainly based on word/sentence length and number of syllables per word. These provide a reading grade in relation to the US schooling system, which is set as a reference for readability grading. However, it would be useful to know which of these formulas has the highest association with information comprehensibility. A number of software applications and websites provide a readability-grade estimate for digital documents. Among these software applications, Readability Studio Professional 2012 [19] has been used in some studies [20,21] to calculate readability grades using different formulas. However, readability-grade estimates produced by Readability Studio software need to be assessed for their validity to measure information comprehensibility.

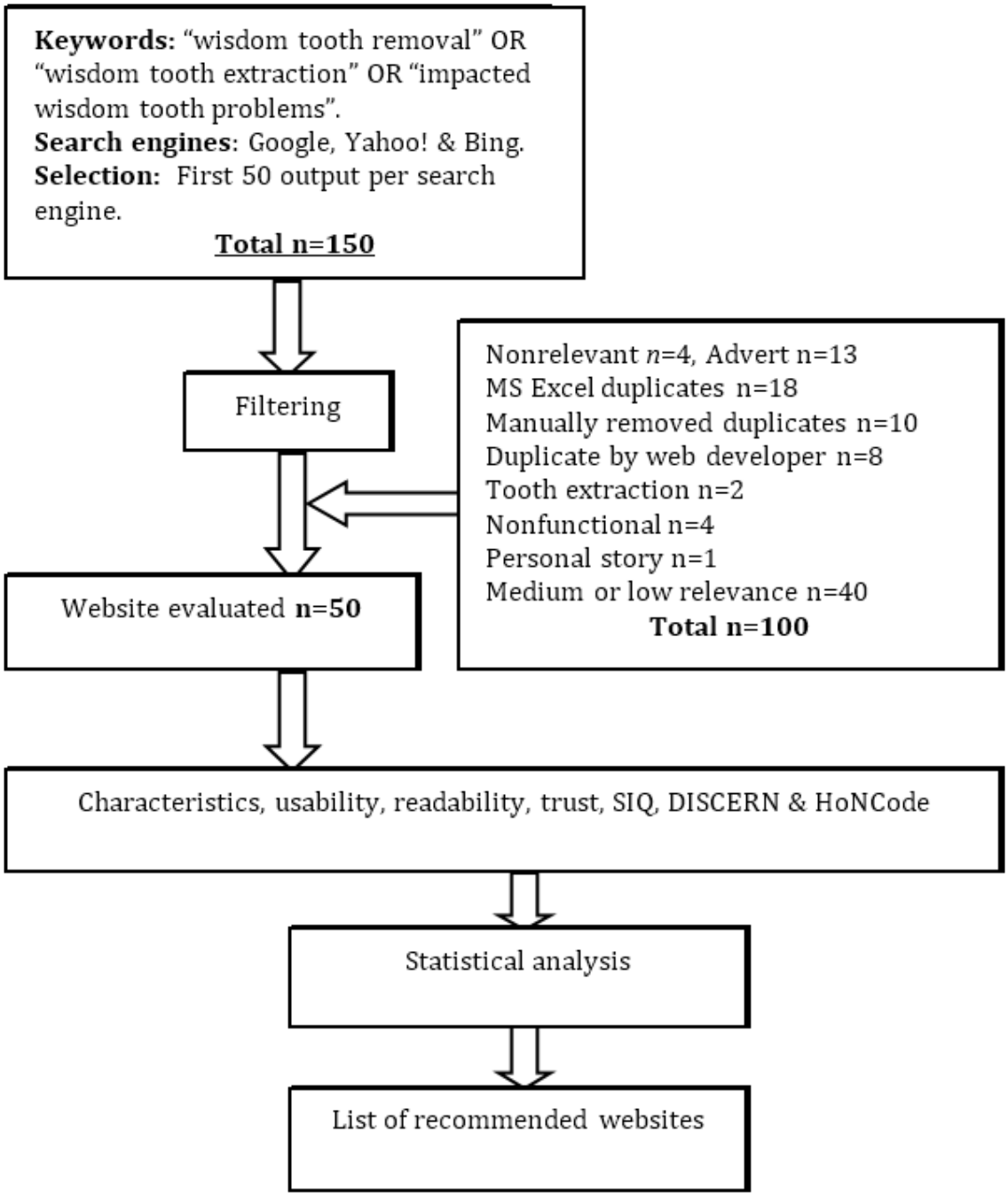
The aims of this study were to (1) develop and validate a scale that measures SIQ; (2) evaluate the quality and readability of online health information concerning TMs problems; (3) validate the Readability Studio Professional 2012 software for measuring comprehensibility of online information; and (4) explore factors that could predict the SIQ of online health information.

Methods

Website Sampling and Filtering

To identify high-quality online resources, a cross-sectional sample of websites was selected on October 14, 2013, using advanced search options in Google, Yahoo!, and Bing search engines, with output limited to English language, any location, and specific phrases in the page title. The 3 phrases used were "wisdom tooth removal" OR "wisdom tooth extraction" OR "impacted wisdom tooth problems." The first 50 results of each search engine output were selected after excluding websites identified as advertisements. A total of 150 websites were initially included. Websites were then filtered by removing duplicates and were reviewed for their relevance as a source for patient information. During this stage, nonfunctional, nonrelevant news articles or blogs were excluded. If a website was found to be relevant, it was categorized as having high, medium, or low relevance based on reporting the predetermined information sections of the SIQ Scale. Only websites of high relevance, according to this classification, were selected for content analysis. Figure 1 shows the flowchart for website sampling and filtering. This review was conducted by KH for consistency and eliminating the need for providing training.

Figure 1. Website content analysis flowchart.



Characteristics of Website

A number of website characteristics that might have an association with the quality of provided information were determined. Website affiliation (to which organization the website belongs to) was recorded as governmental, educational institute, treatment provider (hospital/medical or dental practice), nonprofit organization, commercial [22], or other group. There was an open section that was then coded into blogs, hub pages, wiki (like Wikipedia), or news. As content editing could play a role in information quality, websites were categorized into either "open access" or "open content" where the type of content editing was reported for coding. Information delivery format was recorded, as previous research shows the importance of multimedia use to engage patients of low literacy [23]. Information formats were recorded as a multiple response set that included "text within the webpage," "word/PDF," "images," "cartoon animations," "audio," "real example," and "other," with an open section to enable adding comments, which later were coded into themes. Information communication method was recorded to identify the prevalence of each method. Information communication methods were recorded as a multiple response set that included "fact sheet," "question and answer (Q&A)," "story," and "other" with an open section that was coded into other types of information formats.

Website Evaluation

To assess different quality aspects of websites under evaluation, several scales were used [24]. Quality aspects included scales assessing usability, accessibility, trustworthiness, readability grade [18], scientific information comprehensiveness, scientific information reporting, scientific information referencing, SIQ, and online health information credibility (Health on the Net [25] and DISCERN [26]). The sum of these scales formed the website total score, which was considered as a collective measure of website quality.

Usability Scale

The Usability Scale consisted of items that were partially based on the Minervation Tool (LIDA [27]). These items include registration/subscription to review the information, website navigability, and search ability and were given a score that ranged from 1 to 3 for each item based on the response. For Web 2.0 applications support such as Facebook, Twitter, LinkedIn, and G+, responses were collected as a multiple response set to provide a score that was then trichotomized based on percentile distribution. Usability Scale scores range from 4 to 12.

Accessibility Scale

A single-item Binary Scale that was used as a proxy for compliance with Web Content Accessibility Guidelines [28], with scores being 1 for "No" and 3 for "Yes" to increase item weight in the website total score.

Trust Scale

The Trust Scale was developed for this study and comprised a 4-item Binary Response Scale measuring trust in a website. Items for this scale were display of the Health on the Net (HoN) seal [25], as it is the most frequently used online consumer health information quality seal, validity of the HoN seal using the HoN toolbar, display of other quality seals, and display of planned review date as an indication for maintaining information currency. Items for this scale were scored 1 for "No" and 3 for "Yes" to increase the scale weight within the website total score. The scale scores range from 4 to 12.

Mean Readability Grades

Mean readability grades were computed using Readability Studio Professional 2012 that provides readability grades estimates based on 6 different formulas recommended for the health care industry, which are FORCAST, Fry, Gunning Fog, New Fog, Raygor Estimate, and SMOG. Text from websites was extracted to MS Word (Microsoft, Redmond, WA, USA) where they were prepared for evaluation by the software. In addition, videos were transcribed by the author (KH).

Scientific Information Comprehension Scale

The Scientific Information Comprehension (SI Comprehension) Scale was developed specifically for this study. It comprises a 9-item scale that measures the understandability of each section of the scientific information shown in Table 1. Items for this scale were scored on a 5-point Likert-like scale ranging from 1 "difficult to understand" to 5 "easy to understand." If the item did not exist on the website, it was reported as missing.

Table 1. Evaluation criteria for scientific information quality concerning wisdom tooth problems.

Criteria (assessed on a 5-point Likert-like scale: range from 1 for poor to 5 for excellent)	Description
Overview	Number of third molars (TMs), age of eruption, and etiology of impaction
Presentation	Mild pericoronitis to severe infection of facial spaces, swelling, trismus, periodontitis, decay, cyst, or tuners with incidence. No evidence supports the association between TMs and late teen crowding.
Diagnosis and investigations	Diagnosed by a dentist/oral surgeon, medical and dental history, clinical and radiographic examination, and other radiographs in high-risk TMs
Treatment options	Retain functional TMs, symptomatic TMs with untreatable conditions or associated with pathology should be removed, no evidence supports the removal of asymptomatic impacted TMs, shared decision making. Anesthetic options (local anesthetic, intravenous sedation, or general anesthetic). Pathway (minor oral surgery, hospital day case, or hospital inpatient).
Risk and benefits	Incidence of risks associated with retaining TMs, general surgical risks (pain, bleeding, swelling, etc), anatomical-related risks (numbness of lip or tongue, oroantral fistula), rare risks (tuberosity/mandible fracture)
Surgical procedure	Draping, anesthesia, flap, bone removal, tooth sectioning, tooth removal, socket irrigation, socket inspection, bone filing, suture, and gauze pack
Postoperative care and recovery	Postoperative instructions, how to control pain, bleeding, swelling, infection, and dry/infected socket. Information about diet and oral hygiene. Expected recovery.
Costs associated with the treatment	Depend on pathway: direct cost (surgeon, anesthetize, and/or hospital fees), indirect cost (time off work), insurance information
More information for intravenous sedation and general anesthesia/dental anxiety management	Conscious sedation (oral, inhalation and intravenous sedation), general anesthetic

Scientific Information Reporting Scale

The Scientific Information Reporting (SI Reporting) Scale is a 9-item binary scale that was developed for this study based on reporting information topics, which can be found on the assessed website. Items for this scale were scored 1 if the information section was covered and 0 if the information section was not covered in the examined website. Full scale scores range from 0 to 9. The SI Reporting Scale was used to identify websites of high relevance as a source of information.

Scientific Information Referencing Scale

The Scientific Information Referencing (SI Referencing) Scale is a 9-item Binary Scale that was developed for this study to measure referencing different information sections on the assessed website. Items for this scale were scored 1 if the information section was referenced and 0 if the information section was not referenced, and the full scale scores again range from 0 to 9.

Scientific Information Quality Scale

The SIQ Scale is a 9-item Likert-like scale, which was developed to assess various aspects of information that should be provided to patients, based on literature review and authors' experience in the field (Table 1). Each item was scored on a scale ranging from 1 "poor" to 5 "excellent" against the predetermined criteria for online information concerning TMs problems that was created by this study's authors using the best available evidence (see Multimedia Appendix 1). Domains for this scale included overview (introduction), presentation, diagnosis, treatment options, risks/benefits, procedural information, postoperative care and recovery, costs, and more information about anxiety control. If the item did not exist on the website, it was reported as missing. The SIQ Scale scores range from 9 to 45.

Online Consumer Health Information Credibility Tools

Health on the Net Code Scale

This was a 14-item scale that was developed by authors [24] based on the criteria for providing the HoN seal [25]. Each item had 3 response options, namely, the website was "not complying" with Health on the Net Code (HoNCode) (scored 1), the website was "partially complying" with HoNCode (scored 2), and the website was "fully complying" with HoNCode (scored 3). The HoNCode consists of the following 8 principles: authorship, complementary information, maintaining privacy, appropriate referencing of information sources, claim policy, transparency, disclose funding source, and clear advertising policy. The HoNCode Scale scores range from 14 to 42.

DISCERN Scale

This is a 16-item scale developed by Charnock [26] to assess the credibility of printed consumer health information and was validated for assessment of online consumer health information [29]. Each item was scored 1 for a "definitive no," 2-4 for "partial yes" (based on reviewer's judgment), or 5 for a "definitive yes." The DISCERN items are grouped into 3 main groups: Questions 1-8 are related to reliability of information, Questions 9-15 are related to specific treatment choices, and Question 16 provides an overall quality assessment of the information. The DISCERN Scale scores range from 16 to 80.

Website Total Score

The website total score was used as a measure of the total website quality. It was calculated as an unweighted sum of website usability, trust, SIQ, scientific information comprehensiveness, scientific information referencing, scientific information reporting, accessibility, DISCERN, HoNCode Scales, and the reverse-coded mean readability grade. The website total scores range from 57 to 222.

Reviewer's Comments

To allow the evaluator (KH) to provide qualitative feedback on the assessed websites, the researcher commented on areas of biased/unbalanced information. In addition, the researcher commented on factors that might affect information readability and the recommended treatment options. These comments were then coded into themes and subthemes for analysis.

Data Analysis

Data were analyzed using IBM SPSS Statistics for Windows version 22.0 (IBM, NY, USA) [30]. Frequencies of websites characteristics were calculated. Means, SDs, and quartile distributions were also calculated for each scale. The internal consistency using Cronbach alpha of each scale was calculated. Pearson *r* correlation coefficients were calculated between SIQ Scale, DISERN, and HoNCode. In addition, Pearson *r* correlation between the mean readability grade and the reverse-coded SI Comprehension Scale was measured in an attempt to establish convergent validity. The associations between website affiliation and websites scale scores were tested using one-way analysis of variance (one-way ANOVA) with Tukey post hoc tests.

To explore predictors for SIQ scores, linear regression was performed after creating dummy variables for website affiliation groups. A block of website affiliation dummies (Model 1) was entered in linear regression, where the "other" group was used as a reference category. In Model 2, DISCERN was added, and in Model 3, DISCERN was removed and replaced by the HoNCode score while statistically controlling for website affiliation. Websites were ranked according to their SIQ score and to their total (unweighted) score. The correlation between the 2 ranking orders was examined using Spearman ranking correlation.

The website reviewer's (KH) comments were analyzed using NVivo 10 [31] where comments were coded into themes and subthemes. These themes included biased/unbalanced information (subthemes included areas of biased/unbalanced information), factors affecting information readability (subthemes included repetition, terminologies use, image labeling), and the recommended treatment options (subthemes included obtaining a second opinion, prophylactic removal of all TMs, removal of only symptomatic ones, removal of symptomatic, and seriously think about asymptomatic ones). Cross-tabulation of codes' frequency by the website affiliation group was obtained for unbalanced/biased information, the recommended treatment and factors affecting information

readability, and then weighted according to the percentage of representation of the website affiliation group within the sample.

Results

Websites Characteristics and Their Usability

Of the 50 websites available for content analysis, a majority of the reviewed websites (54%, 27/50) were related to a treatment provider after adding 1 website to this group from the "educational institute" group that has a teaching hospital attached to it. A total of 7 of the 50 (14%) websites were related to commercial websites, and governmental and nonprofit organizations websites were equally represented (8%, 4/50). There were 7 "other" group websites (hub pages, blogs, news, and wiki, 14%). A combination of text and image was the most commonly used information format (40%, 20/50). Question and answer was the most predominant information communication method either alone (34%, 17/50) or in combination with fact sheets (22%, 11/50).

Most websites were open access (74%, 37/50), and the most common form of content editing was posting comments (14%, 7/50). All websites were accessible without either registration or subscription. A majority of websites were judged easy to navigate (62%, 31/50) while slightly above half of the websites (52%, 26/50) had no search facility. Facebook (23% of Web 2.0 applications, 28/121) and Twitter (20% of Web 2.0 applications, 24/121) were the most commonly used Web 2.0 applications.

Scientific Information Quality

The developed SIQ Scale had good internal consistency (Cronbach alpha=.85). Furthermore, the SIQ scores were significantly correlated with DISCERN scores (r=.81, P<.01) and HoNCode (r=.38, P<.01). Less than 25% of the evaluated websites had SIQ scores above 75% of the maximum scale score. The overview section was the most reported information section, whereas the cost information section was the least reported.

Information Credibility Tools

DISCERN had high internal consistency (Cronbach alpha=.91), whereas that for HoNCode was slightly lower (Cronbach alpha=.80). DISCERN and HoNCode were significantly correlated with each other (r=.71, P<.01) and both scales were significantly correlated with the SIQ Scale (as mentioned earlier).

Association of Website Affiliation With Website Scores

One-Way ANOVA showed a significant association between website affiliation and SIQ ($F_{4,45}$=4.8, P<.01), DISCERN scores ($F_{4,45}$=4.8, P<.01), and HoNCode score ($F_{4,45}$=8.8, P<.01). SIQ had an observed power of 90% or over for each of them and had moderate effect size estimates. Website affiliation was also significantly associated with the other scales (Usability, Trust, SI Referencing, and SI Comprehension) except for the mean readability grade where no significant difference was found. Tukey post hoc tests showed that the SIQ mean scores of the "other" website affiliation group was significantly lower than commercial websites (P<.01) and governmental website (P=.01). Table 2 shows the significant association of websites scales mean scores and total score with website affiliation groups.

Table 2. Quality and readability scores by website affiliation.

	Website affiliation[a]										
	Commercial		Treatment provider		Government		Nonprofit organization		Other		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	*P*-value significance
Scientific Information Quality (SIQ)	32.6_a	9.5	26.0_a	7.8	34.8_a	10.9	29.0_a	9.8	17.0_b	7.3	.01
DISCERN	62.3_a	9.3	46.0_b	10.7	59.3_a	17.6	61.8_a	12.1	44.1_b	13.5	<.01
Health on the Net Code	35.4_a	4.3	26.8_b	3.7	35.3_a	2.5	35.8_a	4.9	30.7_a	7.8	<.01
Mean readability grade	10.3_a	0.9	10.6_a	1.4	10.4_a	3.7	11.3_a	2.9	9.0_a	2.7	.34
SI Comprehension	$9.9_{a,c}$	1.3	12.8_b	2.6	$9.8_{a,b,c}$	2.2	$13.5_{a,b}$	7.6	8.3_c	4.5	.01
SI Referencing	10.6_a	2.4	9.1_b	0.5	$9.8_{a,b}$	0.5	11.8_a	3.1	$10.1_{a,b}$	2.3	.01
Trust	5.0_a	1.4	4.1_b	0.4	$4.8_{a,b}$	1.0	$4.5_{a,b}$	1.0	4.0_b	0.0	.03
Usability	10.3_a	1.4	8.4_b	1.1	10.5_a	0.6	9.8_a	1.3	10.4_a	1.4	<.01
SI Reporting	16.9_a	1.6	16.2_a	1.4	17.0_a	2.0	16.3_a	2.2	13.9_b	2.1	.01
Accessibility	1.0_a	0.0	1.1_a	3.0	1.5_b	0.6	1.0_a	0.0	1.0_a	0.0	.02
Total score	153.8_a	26.1	114.3_b	22.3	152.6_a	29.9	144.9_a	26.9	114.0_b	25.4	.02

[a]Values in the same row and subtable not sharing the same subscript are significantly different at P<.05 in the two-sided test of equality for column means. Cells with no subscript are not included in the test. Tests assume equal variances.

Predictors for Scientific Information Quality

Linear regression models (Table 3) showed that website affiliation alone (Model 1) significantly explained 21% of the adjusted R^2 of SIQ scores. Governmental websites had the highest (*B*) coefficients (*B*=17.75, *P*<.01) in comparison to the "other" group that was set as a reference category. After controlling for website affiliation (Model 2), DISCERN scores were found to be significantly associated with the highest SIQ (*B*=.60, *P*<.01). Because DISCERN and HoNCode are measuring a close construct, DISCERN was removed from the regression equation and replaced by HoNCode in Model 3. While controlling for website affiliation, HoNCode was found to significantly predict the SIQ (*B*=.63, *P*=.02). A regression residual scatter plot showed a random distribution while the P-P plot of the observed and the predicted values of the SIQ scores showed a good model fit (data not presented).

Table 3. Scientific Information Quality score prediction models.[a]

Model		Unstandardized coefficients		95% CI for B		Standardized coefficients	*t*	Significance (*P* value)	Model summary		
		B	Standard error	Lower bound	Upper bound	Beta			Adjusted R^2	R^2 change	Significance *F* change
1	Constant	17.00	3.16	10.64	23.36		5.38	<.01	.21	.28[b]	.01
	Commercial	15.57	4.47	6.58	24.57	.58	3.49	<.01			
	Treatment provider	8.96	3.53	1.85	16.08	.48	2.54	.02			
	Governmental	17.75	5.24	7.20	28.30	.52	3.39	<.01			
	Nonprofit organization	12.00	5.24	1.45	22.55	.35	2.29	.03			
2	Constant	-9.50	3.16	-15.87	-3.14		-3.01	<.01	.76	.51[c]	<.01
	Commercial	4.68	2.71	-0.77	10.13	.17	1.73	.09			
	Treatment provider	7.83	1.96	3.87	11.79	.42	3.99	<.01			
	Governmental	8.68	3.05	2.55	14.82	.25	2.85	.01			
	Nonprofit organization	1.43	3.09	-4.80	7.66	.04	0.46	.65			
	DISCERN	0.60	0.06	0.48	0.72	.85	10.09	<.01			
3	Constant	-2.45	8.49	-19.56	14.67		-0.29	.76	.29	.09[d]	.02
	Commercial	12.59	4.41	3.70	21.47	.47	2.85	.01			
	Treatment provider	11.43	3.50	4.38	18.48	.61	3.27	<.01			
	Governmental	14.88	5.11	4.59	25.17	.43	2.91	.01			
	Nonprofit organization	8.81	5.14	-1.54	19.16	.26	1.72	.09			
	Health on the Net Code Scale	0.63	0.26	0.11	1.16	.39	2.45	.02			

[a]The "other" website affiliation group was used as a reference category.

[b]R^2change for Model 1: It is change from a null model.

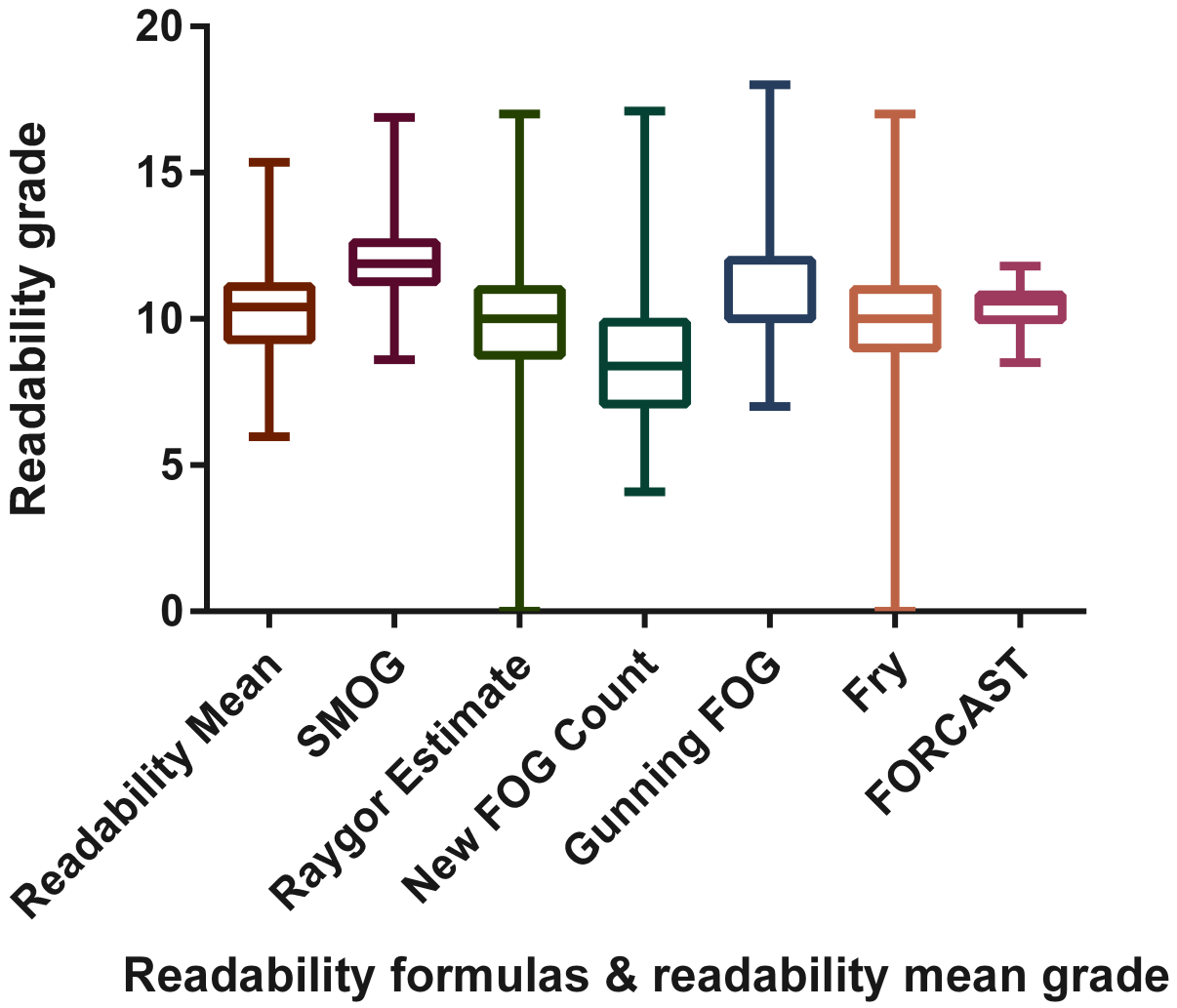
[c]R^2change for Model 2: It is a change from Model 1.

[d]R^2change for Model 3: It is a change from Model 1.

Information Readability Grades and Comprehension

The mean (SD) readability grade (Figure 2) was 10.3 (1.9). Nonprofit organization websites had the highest mean readability grade, whereas the "other" websites had the lowest mean readability grade (Table 2). There was no significant difference in the mean readability grade among website affiliation groups. One-way ANOVA of readability grade estimates (FORCAST, Fry, Gunning Fog, New Fog Count, Raygor Estimate, and SMOG) grouped by website affiliation showed no significant difference except for FORCAST, which was found to be significantly different ($F_{4,45}$=3.2, *P*=.02). Figure 2 shows box plots of 6 different readability grades and the mean readability grade calculated using Readability Studio. After reverse coding of the Scientific Information Comprehension Scale scores, the New FOG readability grade has the highest significant association with it among the used readability formulas (*r*=.48, *p*<.01). In addition, the reverse-coded SI Comprehension Scale scores were found to be significantly correlated with the mean readability grade produced by Readability Studio Professional 2012 (*r*=.45, *P*<.01).

Figure 2. Box plot of readability grades and mean readability grade.



Websites' Ranking

Websites were ranked according to their SIQ scores. Results showed that the Bupa-UK website [32] had the highest SIQ, followed by that of the NHS-UK [33]. Ranking websites according to their total unweighted scoring showed that Bupa-UK had the highest total score followed by Animated-Teeth [34]. Spearman ranking correlation between both ranking orders were significantly correlated (r=.81, P<.01).

Analysis of Reviewer's Comments

The comment section was analyzed using thematic analysis. Biased or unbalanced information provided was coded. TMs and late teen crowding were the most frequently reported biased information (41% of reported biased/unbalanced information, 13/31). Forcing patients to undergo "sleep dentistry" (16% of reported biased/unbalanced information, 5/31) was an example of unbalanced information, where information providers limited the anesthetic options to general anesthesia or sedation without providing local anesthetic as an option. The treatment provider group was associated with the highest frequency of biased/unbalanced information (74% of reported biased/unbalanced information, 23/31), which was also confirmed by the weighted frequencies of biased/unbalanced information across different website affiliation groups.

Comprehensibility of information was affected by the use of terminologies without explanation (28% of reported readability issues, 10/35), and/or the use of illustrations that were incorrectly labeled (5% of reported readability issues, 2/35), or inadequately labeled (5% of reported readability issues, 2/35), or sometimes not relevant at all (11% of reported readability issues, 4/35). In addition, poor information presentation and organization (11% of reported readability issues, 5/35) played an important role in the ability of finding information. Furthermore, repetition was found in some of the reviewed websites (11% of reported readability issues, 5/35).

The most frequently reported treatment option was the removal of symptomatic wisdom teeth and to seriously consider removal of asymptomatic ones (30% of reported treatment options, 7/23), while 4 websites (17% of reported treatment options) recommended the prophylactic removal of all wisdom teeth to "get peace of mind." A number of websites (28% of reported treatment options, 6/23) recommended the removal of only

symptomatic ones. There were instances where patients were advised to get a second opinion (17% of reported treatment options, 4/23) before making a treatment choice related to their wisdom teeth. Coronectomy (removing the crown and retaining the root) as a treatment option for high-risk wisdom teeth was rarely mentioned.

Discussion

Preliminary Findings

In this study, we aimed to provide a guide to assess the quality and readability of online health information with an application on Internet-related information concerning TMs problems using a scale developed for this purpose. The study also identified a shortlist of high-quality resources that might be recommended by clinicians to patients having TMs problems. Because online resources are dynamic, the researchers explored predictors for SIQ that might be used for a quick and easy identification of high-quality online resources.

To identify high-quality resources, a search was carried out using 3 common search engines (Google, Yahoo!, and Bing), and 3 keywords thought to be used by an average patient. While some authors have claimed that patients do not normally go beyond the first 25 results [35], the number of websites included per search query ranged from 10 to 100 websites. Accordingly, we decided to include the first 50 websites per search engine query. The number of websites remaining for thorough evaluation in this study was considered reasonable according to existing literature where the websites included for final analysis ranged from 21 [36] to 67 [37] with a mean of 38 websites per study. In addition, the observed power for the association between website affiliation and website scores was found to be high.

Internet information was delivered using mainly question and answer format either alone or together with fact sheets. Preferences of dental patients in relation to information delivery format need further investigation as there is a knowledge gap in the existing literature in this area. In addition, treatment providers should consider using online forums on their websites supported by health professionals to allow for a better engagement with patients [38]. Despite the importance of multimedia use in patient education [23], a combination of text and images was the most commonly used method of presenting information. There were instances where images were not related to the discussed topic, or were inadequately or incorrectly labeled. It is argued that the use of multimedia is associated with high costs due to professionalism, especially if these websites are for small businesses. Efforts should be made by professional and public health organizations to make multimedia available with permission to use at a reduced or no cost. A majority of websites used Facebook and Twitter as social media for sharing of online information. While many people search for information on the Internet for a family member or a friend [9], information sharing is currently powered by using social media.

Evaluating the quality of scientific information was challenging, especially with the lack of reliable and valid assessment tools. In addition, evaluating the scientific content requires a person who has extensive knowledge in the field. This paper demonstrated that the newly developed SIQ Scale has a high internal consistency and also displayed convergent validity with information credibility tools (DISCERN and HoNCode), which can be used by other researchers. Website affiliation was found to have a significant association with SIQ, usability, accessibility, trust, DISCERN, and HoNCode.

Linear regression models were used to explore the predictors for SIQ. The importance of this step is to make clinicians spend less time and effort to identify high-quality Internet resources, where no content analysis study is available. Website affiliation was able to significantly predict SIQ. Among different groups of website affiliation, governmental websites were found to be associated with the highest predicted SIQ score compared with the reference category. Credibility indicators—either DISCERN or HoNCode—were able to significantly predict SIQ after statistically controlling for website affiliation. A majority of variance in SIQ scores were explained by website affiliation and DISCERN. This finding is important because it might not only improve clinicians' ability to identify high-quality online resources but also improve patients' ability to find these resources by reviewing the governmental websites in light of DISCERN criteria.

Among the reviewed websites, the recommended treatment options were a reflection of the clinical uncertainty related to asymptomatic wisdom teeth [39]. Despite the lack of evidence supporting prophylactic removal of disease-free asymptomatic impacted wisdom teeth [3], there was a tendency to recommend the removal of asymptomatic wisdom teeth to prevent future problems. Conversely, some websites recommended the removal of only symptomatic third molars. Because of the uncertainty regarding asymptomatic wisdom teeth, some websites advised patients to obtain a second opinion. These findings suggested that clinicians should discuss this uncertainty with their patients before making a shared decision, because patients themselves might be confused due to conflicting information [10]. In addition, some websites were not providing patients with evidence-based information; for example, many websites recommended continuous application of ice packs postoperatively despite the best available information from randomized controlled trial evidence, which showed no significant difference on postoperative edema, pain, and trismus when compared with no intervention [40]. Clinicians have a responsibility to apply the current best evidence in the shared decision-making process to reach a decision that is ethical, and in the best interest of the patient. Although cost is known to provoke anxiety for dental patients [41], it was found to be the least reported information. This suggests that providing cost estimates on websites could be useful in avoiding/reducing potential anxiety related to treatment costs.

Among the used readability-grade estimates, the New FOG readability grade was the most powerful in predicting scientific information comprehensibility. The significant correlation between the mean readability grade and Scientific Information Comprehension Scale score suggested convergent validity and consequently that the Readability Studio software could be used to assess information comprehensibility. In this study, the

estimated mean readability grade was higher than Grade 8 as recommended by some health authorities [17]. Attention should be paid to provide information in a way that is patient centered.

The strong and significant correlation between websites' ranking according to their SIQ and their ranking according to total scoring suggested that websites associated with the SIQ were also associated with other quality aspects such as readability, usability, trust, and credibility. Such results suggest that future research might focus on the SIQ Scale, readability-grade estimate, and DISCERN to limit the evaluation process.

The main limitation of this study lay in 2 main areas: sampling bias and examiner bias that were known to the researchers when conducting data collection and analysis. However, effort was made to minimize their impact by using predetermined assessment criteria and to statistically validate the measurements used. In addition, websites were evaluated by the main author who has appropriate academic qualifications and clinical experience—an approach that has been used in previous research [42]. With regard to sampling bias, the retrieved websites were limited to the keywords that were used and search engines on a certain day.

The strengths of our study were (1) the contribution to the field of health informatics such as the development and initial validation of the SIQ Scale and the validation of Readability Studio Professional 2012; (2) contribution to current clinical practice by providing a shortlist of high-quality websites (however, clinicians need to consider the dynamic nature of online resources); (3) the development of criteria for patient information concerning wisdom tooth problems (see Multimedia Appendix 1), which might be used as an information sheet covering all areas of wisdom teeth removal and using the best available evidence; (4) use of a statistical approach to analyze website data that has not been used previously in these kind of studies, such as convergent validity, linear regression using dummy variables, and thematic analysis of open comment section using NVivo 10; and (5) the validation of a readability software application that could be used in future research. The SIQ Scale [24] demonstrated some evidence of both reliability and validity in assessing the SIQ; hence, it might be usable in future research related to the assessment of online health information.

Conclusion

This study provides clinicians with guidance in assessing Internet resources for patients suffering from wisdom tooth problems. However, clinicians may apply similar techniques when recommending websites to patients who suffer from other dental problems. Consumer health information providers should consider evidence-based information, use of multimedia, and information readability during the process of information production. Readability Studio Professional 2012 was found to be valid as a software application for assessing comprehensibility of online health information. Website affiliation and DISCERN were found to play a major role in the prediction of SIQ. Governmental websites were associated with the highest prediction for SIQ. DISCERN and HoNCode as online information credibility tools were significantly able to predict the SIQ. In instances where no guidance is available, patients could review governmental websites in light of DISCERN criteria to identify high-quality information. The developed SIQ Scale had high internal consistency and established convergent validity, suggesting its use in the future to assess the SIQ of online dental information.

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Conflicts of Interest

None declared.

Multimedia Appendix 1

Criteria used for evaluating scientific information quality concerning wisdom teeth problems.

[PDF File (Adobe PDF File), 92KB - ijmr_v4i4e19_app1.pdf]

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Abbreviations

ANOVA: analysis of variance
HoN: Health on the Net
HoNCode: Health on the Net Code
SIQ: scientific information quality
SI Comprehension: Scientific Information Comprehension
SI Referencing: Scientific Information Referencing
SI Reporting: Scientific Information Reporting
TMs: third molars

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Original Paper

Internet Services for Communicating With the General Practice: Barely Noticed and Used by Patients

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Abstract

Background: The Netherlands is one of the frontrunners of eHealth in Europe. Many general practices offer Internet services, which can be used by patients to communicate with their general practice. In promoting and implementing such services, it is important to gain insight into patients' actual use and intention toward using.

Objective: The objective of the study is to investigate the actual use and intention toward using Internet services to communicate with the general practice by the general practice population. The secondary objective is to study the factors and characteristics that influence their intention to use such services.

Methods: There were 1500 members of the Dutch Health Care Consumer Panel, age over 18 years, that were invited to participate in this cross-sectional study. People who had contacted their general practitioner at least once in the past year were included. Participants were asked to fill out a questionnaire about the following services: Internet appointment planning, asking questions on the Internet, email reminders about appointments, Internet prescription refill requests, Internet access to medical data, and Internet video consultation. Participants indicated whether they had used these services in the past year, they would like to use them, and whether they thought their general practice had these services. For the first two services, participants rated items based on the unified theory of acceptance and use of technology complemented with additional constructs. These items were divided into six subscales: effort expectancy, performance expectancy, trust, attitude, facilitating conditions, and social influence.

Results: There were 546 participants that were included in the analyses out of 593 who met the inclusion criteria. The participants had a mean age of 53 years (SD 15.4), 43.6% (n=238) were male, and 66.8% (n=365) had at least one chronic illness. Actual use of the services varied between 0% (n=0, video consultation) and 10.4% (n=57, requesting prescription refill by Internet). The proportion of participants with a positive intention to use the service varied between 14.7% (n=80, video consultation) and 48.7% (n=266, Internet access to medical data). For each service, approximately half indicated that they did not know whether the service was available. Univariate logistic regression analyses revealed that all the constructs as well as age, level of education, and Internet usage had a significant association with intention toward using Internet appointment planning and asking questions by Internet.

Conclusions: Internet communication services to contact the general practice are not yet frequently used by this population. Although a substantial number of persons have a positive intention toward using such services, not all people who receive primary care seem willing to use them. The lack of awareness of the availability and functionality of such services might play an important role.

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KEYWORDS

eHealth; online communication; primary care; general practice

Introduction

Internet Communication Services for Patients in Primary Care

In primary care, there is a growing emphasis on Internet information and communication services (or eHealth) for providing patients with Internet access to the general practice and their medical data. Moving from "traditional care" toward eHealth is a key goal of the European Union. In the digital agenda for Europe, 3 specific actions are stated: widespread deployment of telemedicine, patients' access to their medical data, and interoperability [1]. The Netherlands, Denmark, Sweden, Finland, and the United Kingdom are frontrunners in the field of eHealth in Europe [2]. Of these frontrunners, the Netherlands leads in the percentage of households with an Internet connection and broadband connection. In addition, the Netherlands has the highest percentage of people who are regular Internet users and who use eGovernment services [2]. A recently published eHealth monitor (a part of which provided the data for this study) describes the development and progress of eHealth in the Netherlands [3]. It reported that 91% of 304 surveyed general practitioners (GPs) offered one or more Internet services to their patients by which they could contact their GP or the general practice. The most frequently offered services were Internet prescription refill requests (66%) and the ability to ask questions via email or websites (56%). In addition, 14% of the GPs indicated that they offered services to plan appointments on the Internet and 25% indicated that they intended to implement this service within 1 year.

The implementation of Internet communication services in primary care is expected to have positive effects because these services can increase the efficiency of care, patient satisfaction, and quality of care [4-8]. For instance, previous research has indicated that the use of an Internet messaging system or the use of email for communication in primary care practice can reduce the number of office visits (but not phone consultations) [4], can improve the communication between health care providers and patients [5,7], and is assessed by patients as convenient, time saving, and useful [6].

Investigating Internet Services for Patients

Although these results are promising, previous research has shown that these services are not routinely used [9] and not frequently accepted by patients [10]. To predict patients' willingness to use a service, physical, psychological, and social factors, and the needs of patients, have to be understood [10]. To improve future adoption, the actual use of Internet communication services and the factors that influence the intention to use such services should be investigated.

The technology acceptance model (TAM) [11] is the most well-known and robust model for testing technology acceptance. The TAM model theorizes that beliefs about perceived ease of use and perceived usefulness are the main constructs predicting user intention. In recent years, this model has been extended and modified in a dozen studies. One of the extended TAM models is the unified theory of acceptance and use of technology (UTAUT) [12]. Besides ease of use (in this model called "effort expectancy") and perceived usefulness (called "performance expectancy"), 2 other key constructs are added in the UTAUT model: social influence and facilitating conditions. In addition, gender, age, experience, and voluntariness of use are included in this model as moderators that influence the key constructs on intention to use. The TAM and UTAUT models have been frequently applied in health care research [13]. However, they are not often utilized to investigate patient acceptance of eHealth services [10]. These TAMs are constantly evolving. Or and Karsh [10] suggested in their review that, besides the before mentioned constructs, the influence of trust on patients' acceptance should be further explored, because trust is found to be a predictor of technology acceptance in research outside the field of health care. In addition, attitude is not a direct determinant in the original UTAUT model of Venkatesh [12]. However, several studies suggest that there is a relation between attitude and intention, for example [14].

The primary objective of this study is to investigate the actual use and intention toward using Internet services to communicate with the general practice by the general practice population. The secondary objective is to get insight into characteristics and factors that influence the intention to use such services by the general practice population. The goal of the study was not to develop and validate a new model to predict patients' intention to use Internet communication services. For the secondary objective, 2 services are specifically studied: making an appointment on the Internet (related to the Internet accessibility of the general practice) and asking a question via email or a website (related to gathering information about health content on the Internet). These services are relatively easy to access, but can have a major impact on daily care routines. The focus was on these 2 services because many general practices already offer them to their patients or intend to implement these services in the near future.

Methods

Design and Participants

There were 1500 participants of the Dutch Health Care Consumer Panel [15], aged over 18 years, who were invited to take part in this cross-sectional study. This panel was established by the Netherlands Institute for Health Services Research (NIVEL) and the Dutch Consumer Association. The sample was representative of the Dutch population in terms of age and gender based on data of Statistics Netherlands [16]. People who contacted the GP at least once in the past year were included in this study. Questionnaires were used for data collection. The panel members could choose whether they wanted to receive a questionnaire by post or email. The questionnaires were issued in April 2013.

Measurements

Participant Characteristics

The background characteristics of the members of the health care consumer panel had already been gathered using a questionnaire that was completed at the start of their membership. For this study, the following characteristics were used: gender, age, level of education, and whether they had none or at least one chronic disease. Furthermore, participants indicated whether they rated Internet use as easy or difficult on a 5-point Likert scale, ranging from 1 (very difficult) to 5 (very easy). In addition, they could indicate that they did not use the Internet.

Use, Intention to Use, and Availability of Internet Services

Participants were asked to fill out a questionnaire regarding the use of the following 6 Internet services to communicate with the general practice: (1) Internet appointment planning, (2) asking questions by Internet via email or a website, (3) email reminders about appointments, (4) Internet prescription refill requests, (5) Internet access to medical data, and (6) Internet video consultation. Participants were asked to indicate whether they had used these services in the past year. If they had not used the service in the past year, the participants were asked about their intention toward using the service (either positive or negative intention). They could also indicate that they did not know whether they would like to use the service. Furthermore, the participants indicated whether they thought these services were available at their general practice or not, or that they did not know whether this service was available.

Factors Influencing Intention to Use Internet Services

To study which factors influence the intention to use Internet appointment planning and the asking of questions by Internet via email or a website, participants rated items on a 4-point Likert scale, ranging from 1 (strongly disagree) to 4 (strongly agree). For these questions, the option of "don't know" was added. For both services, participants rated items that were divided according to the following 6 subscales: effort expectancy (2 items), trust (2 items), attitude (1 item), facilitating conditions (1 item), social influence (1 item), and performance expectancy (3 items). For the service of asking questions via email or a website, 2 items were added to the performance expectancy scale. The items regarding effort expectancy, facilitating conditions, social influence, and performance expectancy were mainly based on the validated UTAUT model [12], as well as on recommendations of studies by Or and Karsh (trust) [10] and Spil and Schuring (attitude) [14]. First, the items of the 6 subscales were asked for Internet appointment planning, and, subsequently, for the service of asking questions by Internet. Participants' mean scores on each subscale were calculated. A list of all the items is presented in Appendix 1 (see Multimedia Appendix 1).

Statistical Analyses

Descriptive analyses were conducted to study participant characteristics and to investigate participants' actual use, intention toward using, and awareness of availability regarding the 6 Internet services. Only participants who filled out all items regarding each of these were included in the analyses. The outcomes are expressed in percentages or in means and SDs.

Linear correlation analyses were conducted to identify multicollinearity in the 6 constructs of effort expectancy, trust, attitude, facilitating conditions, social influence, and performance expectancy for the 2 Internet services: Internet appointment planning and asking questions via email or a website. Items based on the UTAUT model, which were scored as "don't know," were analyzed as missing data. In addition, variance inflation factors (VIFs) were calculated to assess multicollinearity. Correlation coefficients above .8 were considered high, and VIF values above 10 [17] were considered to be unacceptable. Therefore, constructs with a VIF value above 10 were left out of further analyses.

To test which characteristics and factors influence participants' intention toward using the 2 services, univariate logistic regression analyses were conducted. In these analyses, intention to use (1=users + nonusers with a positive intention, 0=nonusers with a negative intention) was the dependent variable. For each of the 2 services, 6 univariate logistic regression analyses were conducted with the mean scores of the following subscales as independent variables: effort expectancy, performance expectancy, trust, attitude, facilitating conditions, and social influence. In addition, 5 univariate logistic regression analyses were conducted with the following characteristics as independent variables: gender (1 = male, 0 = female), age (1 = ≥65 years, 0 = <65 years), chronic condition (1 = at least one, 0 = none), level of education (low, middle, and high), and Internet usage (1 = easy and very easy, 0 = nonuser, very difficult, difficult, and neutral). Outcomes were expressed in odds ratios (OR) and 95% confidence intervals (CI). Bonferroni correction is applied to reduce the bias of multiple testing. All effects are reported at a P=.005

Results

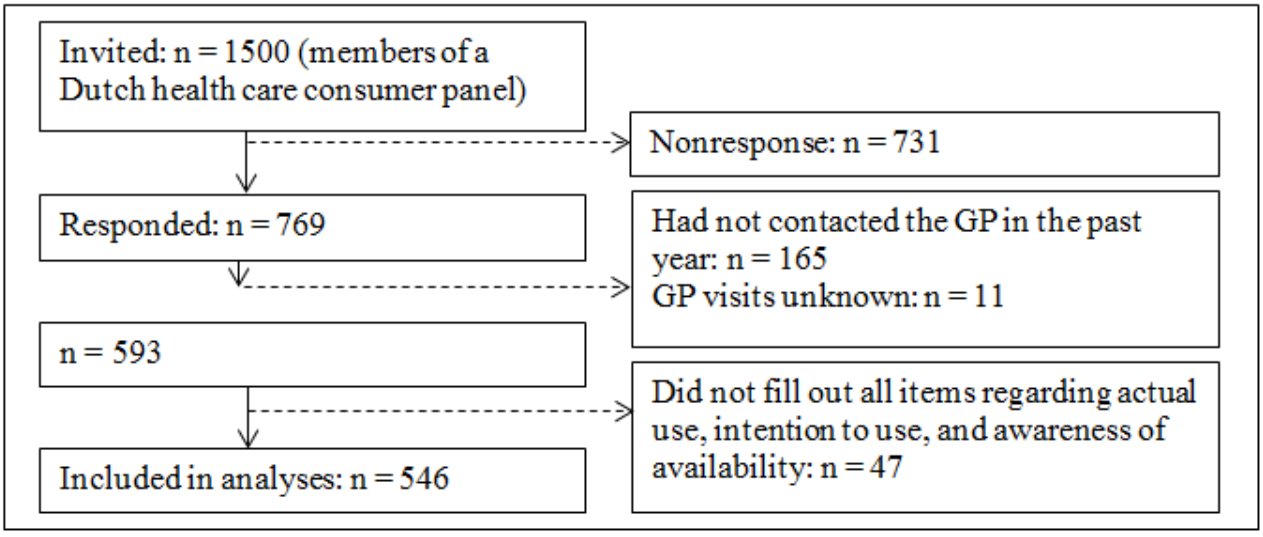
Participants

Figure 1 shows a flowchart of the process of the inclusion of participants. Out of 1500 participants, 769 responded to the questionnaire (63.3%, 487, of these participants responded by Internet). Of these participants, 176 were excluded because they had not contacted their GP in the past year (n=165) or did not respond to the question concerning GP visits (n=11). Furthermore, participants were excluded from further analyses if they did not fill out all items regarding actual use, intention toward using, and awareness of availability of all 6 services (n=47). This resulted in a total sample of 546 participants. Table 1 shows the characteristics of the study sample.

Table 1. Characteristics of the study sample (n=546).

Characteristics		Mean (SD) or n (%)
Age in years		53.14 (15.4)
Gender		
	Men	238 (43.6)
	Women	308 (56.4)
Level of education		
	Low	69 (12.6)
	Medium	306 (56.0)
	High	156 (28.6)
	Unknown	15 (2.8)
Chronic condition (self-reported)		
	None	132 (24.2)
	At least one	365 (66.8)
	Unknown	49 (9.0)
Internet usage		
	No internet	35 (6.4)
	(Very) difficult or neutral (score 1, 2, 3)	141 (25.8)
	(Very) easy (score 4, 5)	352 (64.5)
	Unknown	18 (3.3)
Data collection		
	By post	189 (34.6)
	By internet	357 (65.4)

Figure 1. Flowchart of participants included in the study. GP: general practitioner.



Use, Intention to Use, and Awareness of Availability of Internet Services

Overall, the actual usage of Internet services to communicate with the general practice is low. Not one of the participants had an Internet video consultation with the GP in the past year, 0.4% (2/546) had Internet access to their medical data, 0.6% (3/546) received email reminders about appointments, 2.2% (12/546) planned an appointment by Internet, and 2.9% (16/546) asked a question via email or a website. Requesting a prescription refill by Internet was the most frequently used service (10.4%, 57/546). Figure 2 shows an overview of the results.

Participants who had not used the Internet service in the past year could indicate whether they would like to use the service

in the future. These results are also presented in Figure 2. The percentage of participants who had a positive intention toward Internet video consultation was 14.7% (80/546). Approximately one third of the participants had a positive intention toward receiving email reminders about appointments (33.5%, 183/546), Internet appointment planning (34.2%, 187/546), and asking questions via email or a website (35.0%, 191/546). The highest percentages of participants with a positive intention were found for Internet prescription refill requests (45.8%, 250/546) and having access to medical data (48.7%, 266/546). The percentage of participants with a negative intention varied between 22.7% (124/546, Internet prescription refill requests) and 55.3% (302/546, Internet video consultation). For each service, more than one fifth of the participants responded that they did not know whether they would like to use the Internet service, ranging from 21.1% (115/546, Internet prescription refill requests) to 30.0% (164/546, Internet video consultation).

Figure 3 shows the percentage of people who either knew or did not know whether each of the Internet services was available at their general practice. There were 1.3% (7/546) of the participants who responded that Internet video consultation was possible at their GP, and 20.7% (113/546) responded that requesting a prescription refill by Internet was possible. However, those who indicated that Internet services were not available at their general practice ranged from 31.7% (173/546) of the sample, who indicated that requesting prescription refills by Internet was not available, to 44.0% (240/546), who indicated that Internet video consultation was not available. In addition, for each Internet service, approximately half of the participants did not know whether the service was available at their primary care center.

Associations Between Factors and Intention to Use Internet Services

Tables 2 and 3 show the correlation matrices of the constructs (effort expectancy, performance expectancy, trust, attitude, facilitating conditions, and social influence). The number of participants included in separate correlation analyses differs, due to many “don’t know” responses to items. There were 115 participants who answered all the items (n=10) regarding the constructs that can influence intention to use Internet appointment planning, without using the “don’t know” option; 94 participants did this regarding asking questions by Internet via email or a website (12 items). The correlations between all constructs were statistically significant and higher than or equal to r=.45 (P<.001) for both services. Of the correlation coefficients between the independent constructs that could influence Internet appointment planning, 6 correlation coefficients exceeded the value of .80, which is considered to be high: trust was related to effort expectancy (r=.82), attitude (r=.81), and social influence (r=.81); and attitude was related to facilitating conditions (r=.85) and social influence (r=.86). VIFs were calculated to identify the extent to which the constructs were interrelated. Not one of the VIF values exceeded the cutoff point of 10, indicating that the assumption of multicollinearity was not violated. For constructs influencing the intention toward using a service to ask questions via email or website, 2 correlation coefficients were found which exceeded the value of .80: trust was related with effort expectancy (r=.86) and facilitating conditions (r=.85). In addition, the VIF value for trust was 12.92, which exceeds the cutoff point. Therefore, the construct trust was left out of the univariate logistic regression analysis.

Figure 2. Percentage of participants who had used the Internet care service in the past year, and participants’ intention toward the use of the Internet services.

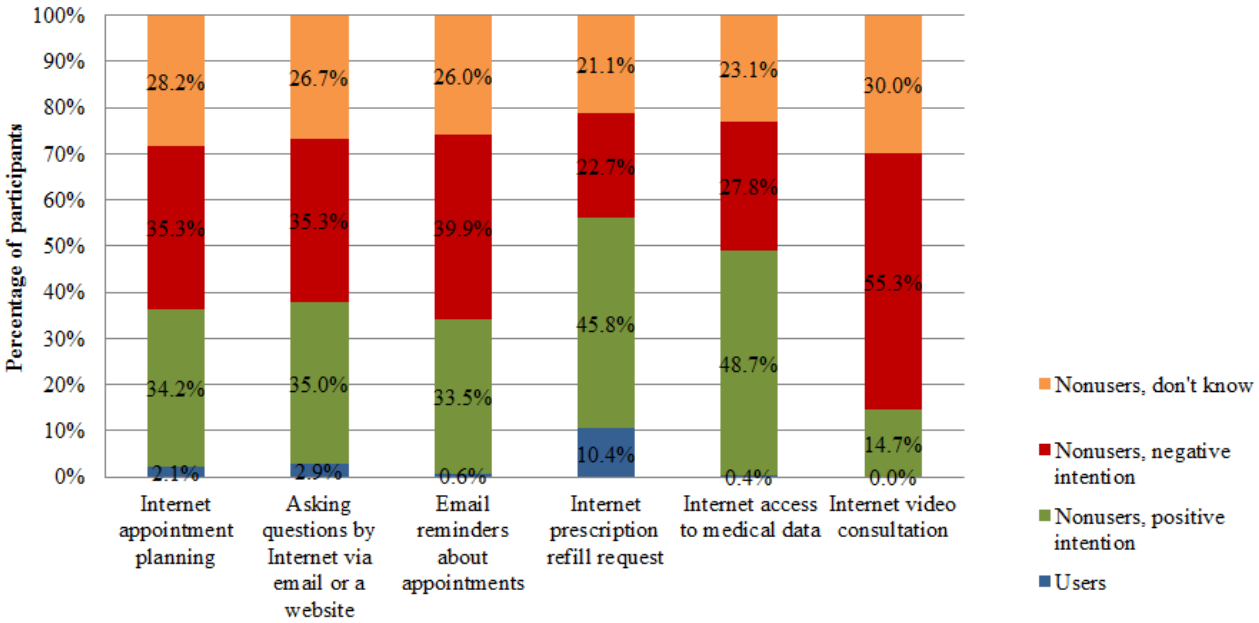


Figure 3. Participants' awareness of the availability of Internet care services at their primary care practice. GP: general practitioner.

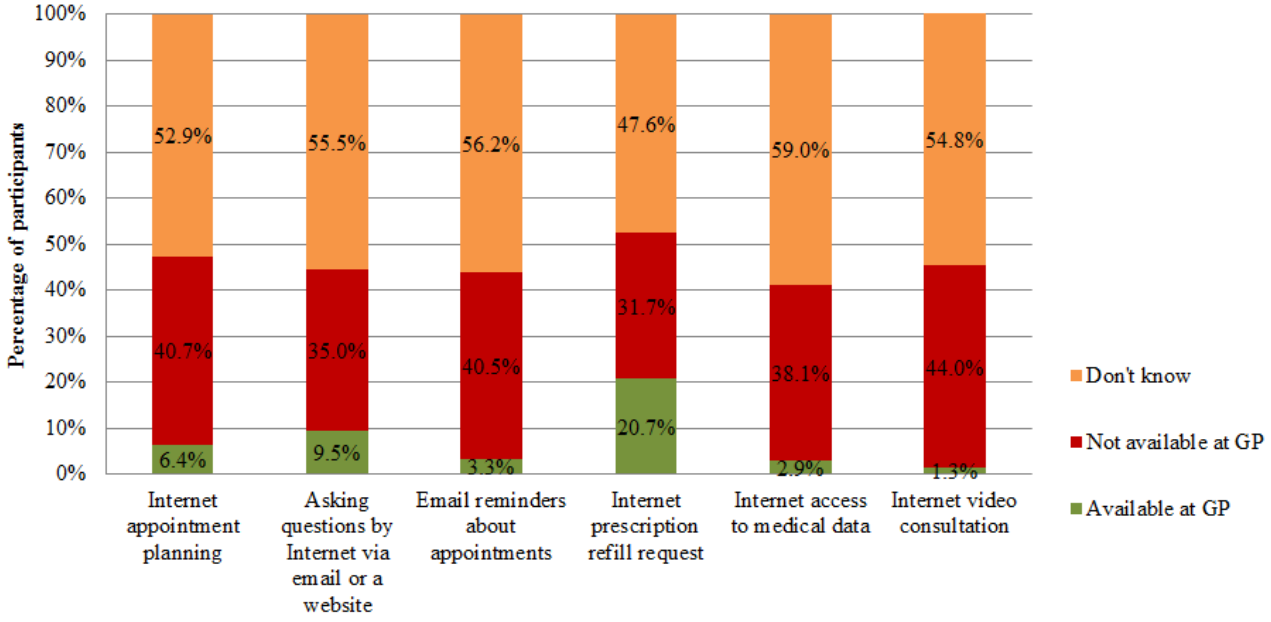


Table 2. Matrix of linear correlations and variance inflation factor values between the independent constructs that could influence intention to use Internet appointment planning.[a]

	EE[b]	PE[c]	TR[d]	AT[e]	FC[f]	VIF value[g]
1. EE						7.25
2. PE	.45 n=314					1.75
3. TR	.82 n=263	.56 n=259				7.08
4. AT	.71 n=283	.61 n=312	.81 n=249			8.84
5. FC	.73 n=314	.53 n=347	.75 n=261	.85 n=308		4.56
6. SI[h]	.78 n=162	.63 n=186	.81 n=154	.86 n=167	.80 n=176	4.05

[a]All results are found to be significant at the $P<.01$ level.

[b]EE: effort expectancy

[c]PE: performance expectancy

[d]TR: trust

[e]AT: attitude

[f]FC: facilitating conditions

[g]VIF: variance inflation factor

[h]SI: social influence

Table 3. Matrix of linear correlations and variance inflation factor values between the independent constructs that could influence intention to ask questions by Internet via email or a website.[a]

	EE[b]	PE[c]	TR[d]	AT[e]	FC[f]	VIF value[g]
1. EE						7.35
2. PE	.56 n=307					2.93
3. TR	.86 n=244	.63 n=247				12.92
4. AT	.60 n=259	.69 n=307	.77 n=221			4.42
5. FC	.79 n=287	.64 n=319	.85 n=237	.70 n=279		6.98
6. SI[h]	.73 n=142	.76 n=158	.80 n=132	.78 n=144	.74 n=142	4.65

[a]All results are found to be significant at the $P<.01$ level.

[b]EE: effort expectancy

[c]PE: performance expectancy

[d]TR: trust

[e]AT: attitude

[f]FC: facilitating conditions

[g]VIF: variance inflation factor

[h]SI: social influence

Table 4 shows the results of the univariate logistic regression analyses. All constructs (effort expectancy, performance expectancy, trust, attitude, facilitating conditions, and social influence) had a significant association with intention to use Internet appointment planning and asking questions via email or a website. For Internet appointment planning, the ORs varied between 3.28 (95% CI 2.21-4.86) for effort expectancy and 8.51 (95% CI 5.15-8.51) for attitude. For asking questions via email or a website, the ORs varied between 5.46 (95% CI 4.34-7.86) for social influence and 7.91 (95% CI 4.53-13.82) for facilitating conditions.

Table 4. Univariate association of constructs and characteristics with intention toward using Internet appointment planning and asking questions by Internet via email or a website. All constructs and characteristics had a significant association with intention to use both services, except for gender and chronic condition.

Independent variable	Dependent variable: intention to use Internet appointment planning		Dependent variable: intention to use a service to ask questions by Internet via email or a website	
	n	Odds ratio (95% CI)	n	Odds ratio (95% CI)
Perceived ease of use	264	3.28 (2.21-4.86)	252	5.46 (3.27-9.13)
Perceived usefulness	301	3.98 (2.58-6.14)	284	5.47 (3.44-8.70)
Trust	226	5.16 (3.21-8.15)	—	—
Attitude	263	8.51 (5.15-14.07)	238	5.85 (3.63-9.43)
Facilitating conditions	283	5.32 (3.51-8.08)	254	7.91 (4.53-13.82)
Social influence	150	4.80 (2.83-8.16)	119	4.34 (2.46-7.68)
Gender	392	0.90 (0.06-1.33)	400	0.92 (.62-1.37)
Age	392	0.172 (0.10-.29)	400	0.14 (.084-.24)
Level of education	380	2.53 (1.78-3.60)	387	2.24 (1.58-3.17)
Chronic condition	357	0.79 (0.49-1.26)	361	0.71 (.44-1.14)
Internet usage	381	7.98 (4.74-13.44)	389	7.97 (4.97-13.23)

Looking into characteristics of participants, age, level of education, and Internet usage had a significant association with intention to use Internet appointment planning and asking questions via email or a website. The ORs for age were 0.172 (95% CI 0.10-0.29) and 0.14 (95% CI 0.084-0.24), respectively. The ORs for level of education were 2.53 (95% CI 1.78-3.60)

and 2.24 (95% CI 1.58-3.17), respectively. ORs for Internet usage were 7.98 (95% CI 4.74-13.44) and 7.97 (95% CI 4.97-13.23), respectively.

Discussion

Principal Results and Comparison With Previous Work

This study indicates that Internet communication services used for contacting the general practice by the general practice population are not yet frequently used in the Netherlands. Of the participants who had not used the service in the previous year, the percentage of participants with a positive intention toward using a service varied between approximately 15% (Internet video consultation) and approximately 5% (having access to medical data). Many participants were not aware of the availability of such services at their general practice, as approximately half of the participants did not know whether such a service was available at their primary care center. Possible factors and characteristics that influence intention to use Internet communication services were investigated in this study. Univariate logistic regression analyses revealed that the following constructs had a significant influence on intention to use Internet appointment planning and asking questions via email or a website: effort expectancy, performance expectancy, trust, attitude, facilitating conditions, social influence, the characteristics of age, level of education, and Internet usage. However, many participants responded with "don't know" to items regarding intention. In addition, high correlations are found between the constructs. This indicates that the Dutch population has no strong view regarding the use and possibilities of Internet services for communicating with the general practice.

In this study, it is found that the use of the Internet to communicate with the general practice is still low. This is in line with findings of previous research [9,18-20]. Although the actual use of such Internet services is low, the Internet is frequently used for health purposes in Europe [18]. It is even the main source of health-related information for the Dutch population [21]. Access to the Internet and the availability of Internet communication services are the key preconditions for successful uptake and usage of Internet services. These conditions seem to be promising in the Netherlands: 94% of households have access to the Internet at home, and 55% of people between 65 and 75 years of age access the Internet almost every day [16]. In addition, more than 90% of GPs offer Internet communication services to their patients [3]. One of the reasons that the actual use of these services is not as high as expected might be that the general practice population is not aware of the availability of the Internet services offered by their primary care practice. In this study, less than 20.7% (113/546) of participants indicated that an Internet service was available at their general practice. Moreover, at least 47.6% (260/546) of the study sample did not know if an Internet service was available at their primary care practice. This is in contrast with the high number of primary care practices that offer such services [3]. Our study confirms the findings of previous research, which has concluded that often patients do not know about the existence of eHealth applications or they are not aware of the possibilities of the applications [22]. Moreover, Mair et al [23] concluded in their review of factors that promote or inhibit the implementation of eHealth services that specifying the purposes, benefits, and values of eHealth services to users during the implementation (the "sense-making" process) is not well covered in previous studies. The fact that the general practice population is not well informed about the availability and possibilities of Internet services might explain the high number of "don't know" responses in our study.

Effort expectancy, performance expectancy, trust, attitude, facilitating conditions, and social influence are found to be constructs that influence the intention to use Internet communication services by the general practice population. However, in looking into the relationships between the independent constructs in this study, moderate to high correlations were found. Although the assumption of multicollinearity is only violated for 1 variable (trust), it should be questioned whether these subscales measure different constructs. Although the UTAUT model is frequently applied in health research [13], it is not yet frequently used to investigate patients' intention toward using Internet services in health care [10]. In the few studies that have applied (a modified version of) this model to predict patient acceptance of Internet services that support self-management, high correlations between the independent constructs were either not reported [24,25] or not found [26]. Furthermore, in studies that have applied the UTAUT model to examine health care professionals' acceptance of eHealth services, low to moderate correlations between constructs have been found, for example [27,28]. It might be the case that Internet services for communicating with the general practice is not a major issue in Dutch society and therefore participants had no strong opinion about these services. Further research is recommended to investigate whether the UTAUT model is applicable for the investigation of intention to use Internet communication services by the general practice population.

The influence of patient characteristics on intention to use eHealth services is well studied [10]. In this study, an older age, lower level of education, and the rating of Internet usage as difficult, is associated with a negative intention. This is in line with most, but not all, previous research which is studied in the review by Or and Karsh [10]. Some researchers argue that the negative association between age and information and communication technology (ICT) usage will disappear within a few years as the older generation become more familiar with using it; however, a recent study by Heart and Kalderon [29] found that although there is an increase in ICT adoption among older people, they are not yet ready to adopt health-related ICT. In their study, "no need" to use ICT was found to be the most prevalent reason for nonuse, and therefore, it is suggested that health care providers should clearly demonstrate the benefits of Internet services to their customers. In this study, no association between gender and intention to use Internet communication services in primary care was found, which corroborates most previous studies [10]. Having no, or at least one, chronic condition was not associated with intention to use. The effect of patient health status on the use of eHealth services has yielded mixed results in previous research [10]: some studies

have found no association between these constructs, for example [30], whereas others have found increased acceptance in people with a better, for example [31], or a poorer health status, for example [32,33]. Furthermore, Heart and Kalderon [29] found that health status moderated the effect of age on use. In this study, participants could indicate their chronic conditions using a questionnaire. However, having one or more chronic condition(s) does not automatically result in different health-seeking behaviors. The number of general practice visits might indicate this better. Future research is recommended to investigate whether this has an influence on intention to use Internet communication services in primary care.

Strengths and Limitations

A strength of this study is that it aimed to investigate the actual use and intention to use Internet communication services, which are currently being implemented in primary care practices. A high number of participants (n=546) between 18 and 83 years of age participated in this study. However, this was not a representative sample of the actual Dutch patient population, which visits the GP at least once a year [34]. There was an underrepresentation of elderly people, which could have led to an overestimation of the intention to use Internet services, because age is found to be associated with intention to use.

Another limitation of this study is that participants who actually used an Internet service were not asked whether they had a positive or negative intention toward using the service in the future. However, because they should have had a positive intention toward using it in the past, these participants were analyzed as having a positive intention. In addition, the true availability of the Internet communication services was not investigated in this study. While the overall percentage of primary care practices that offer such services is known, it is not known whether these services were also available for participants of this study.

The main content of the questionnaire to investigate intention to use the service of Internet appointment planning and asking questions by Internet is based on the validated UTAUT model [12]. The subscales of trust and attitude are not validated. However, the goal of the secondary objective was not to develop a new validated model that predicts patients' intention to use Internet care services. In addition, it is not claimed that the included factors are the only predictors of intention to use Internet care services. The goal was to get insight into possible predictors of intention to use Internet communication services by the general practice population by applying suggested predictors found in literature.

Participants could choose to receive the questionnaire on paper or via the Internet. The use of a mixed data collection methodology could be seen as a limitation of this study. However, based on previous research, it is not expected that this significantly influenced the results [35,36]. In addition, by giving the participants the choice to fill out the questionnaire on paper or via the Internet, a broader study sample was covered.

No multivariate logistic regression analyses could be performed, due to too many "don't know" responses to items that could influence intention to use Internet communication services in primary care, which were analyzed as missing data. Therefore, it could not be indicated which of the studied constructs has the strongest association with intention to use. Moreover, due to the fact that "don't know" responses were analyzed as missing data, the studied sample only consists of people who actually had an opinion (positive or negative) about the Internet communication services. This could have led to a misrepresentation of the sample. An alternative option for dealing with missing data due to "don't know" responses is to impute the mean score of a subscale to the missing value of that subscale. However, this method could not be applied because 3 subscales consisted of 1 item and many participants filled out "don't know" to all items in 1 subscale. Another option is imputing a neutral response (score 2.5) for missing data. Although the authors believe that this is not the same as "don't know," repeating the univariate analyses with this response option did not change the results. In addition, the high number of "don't know" responses to the items suggests that people have difficulties in evaluating their expectations of the use of Internet communication services in primary care. By giving them the option of "don't know," they were not forced to choose between agree and disagree, resulting in a more reliable set of responses.

Conclusions

This study has found that Internet communication services to contact the general practice are not yet frequently used by the general practice population. Many participants indicated that they did not know whether such a service was available at their primary care center. In addition, although a substantial number of people had a positive intention toward using such services, the entire general practice population did not seem willing to use them. Informing the general practice population about the availability and possibility of such services during their implementation might be important for stimulating the uptake and usage of Internet communication services in primary care.

Acknowledgments

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Conflicts of Interest

None declared.

Multimedia Appendix 1

Items related to the constructs that influence intention to use Internet services, rated on a four-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree).

[PDF File (Adobe PDF File), 162KB - ijmr_v4i4e21_app1.pdf]

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Abbreviations

CI: confidence interval
GP: general practitioner
ICT: Information and communication technology
NIVEL: Netherlands Institute for Health Services Research
OR: odds ratio
TAM: technology acceptance model
UTAUT: unified theory of acceptance and use of technology
VIF: variance inflation factor

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Original Paper

Use of Commonly Available Technologies for Diabetes Information and Self-Management Among Adolescents With Type 1 Diabetes and Their Parents: A Web-Based Survey Study

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Abstract

Background: For individuals with Type 1 diabetes (T1D), following a complicated daily medical regimen is critical to maintaining optimal health. Adolescents in particular struggle with regimen adherence. Commonly available technologies (eg, diabetes websites, apps) can provide diabetes-related support, yet little is known about how many adolescents with T1D use them, why they are used, or relationships between use and self-management.

Objective: This study examined adolescent and parent use of 5 commonly available technologies for diabetes, including proportions who use each technology, frequency of use, and number of different technologies used for diabetes. Analyses also investigated the reasons adolescents reported for using or not using technologies for diabetes, and factors correlated with adolescents' technology use. Finally, this study examined relationships between the type and number of technologies adolescents use for diabetes and their self-management and glycemic control.

Methods: Adolescents (12-17 years) and their parents (N=174 pairs), recruited from a pediatric diabetes clinic (n=134) and the Children with Diabetes community website (n=40), participated in this Web-based survey study. Glycosylated hemoglobin (A1C) values were obtained from medical records for pediatric clinic patients. Adolescents reported their use of 5 commonly available technologies for diabetes (ie, social networking, diabetes websites, mobile diabetes apps, text messaging, and glucometer/insulin pump software), reasons for use, and self-management behavior (Self-Care Inventory-Revised, SCI-R).

Results: Most adolescents and parents used at least one of the 5 technologies for diabetes. Among adolescents, the most commonly used technology for diabetes was text messaging (53%), and the least commonly used was diabetes websites (25%). Most adolescents who used diabetes apps, text messaging, or pump/glucometer software did so more frequently (≥2 times per week), compared to social networking and website use (≤1 time per week). The demographic, clinical, and parent-technology use factors related to adolescents' technology use varied by technology. Adolescents who used social networking, websites, or pump/glucometer software for diabetes had better self-management behavior (SCI-R scores: beta=.18, *P*=.02; beta=.15, *P*=.046; beta=.15, *P*=.04, respectively), as did those who used several technologies for diabetes (beta=.23, *P*=.003). However, use of diabetes websites was related to poorer glycemic control (A1C: beta=.18, *P*=.01).

Conclusions: Adolescents with T1D may be drawn to different technologies for different purposes, as individual technologies likely offer differing forms of support for diabetes self-management (eg, tracking blood glucose or aiding problem solving).

Findings suggest that technologies that are especially useful for adolescents' diabetes problem solving may be particularly beneficial for their self-management. Additional research should examine relationships between the nature of technology use and adolescents' T1D self-management over time.

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KEYWORDS

diabetes mellitus, Type 1; adolescent; technology; adoption; self-management; self-care

Introduction

In the United States, approximately 20,000 youth under age 20 years are diagnosed with Type 1 diabetes (T1D) annually [1]. For individuals with T1D, maintaining optimal current and future health outcomes requires adherence to a complex daily regimen with multiple behavioral demands such as monitoring blood glucose, counting carbohydrates, and dosing insulin at appropriate times throughout the day [2]. Additional factors, such as illness or physical activity, may require additional adjustments to the frequency, timing, and calculations associated with insulin self-management.

Substantial empirical evidence links adherence to one's T1D regimen to favorable glycemic control [3]. Glycemic control is most commonly assessed via the 2-3 month average of an individual's glucose levels assessed with the measurement of hemoglobin A1C (A1C). Maintaining glycemic control is in turn predictive of reduced long-term risks for retinopathy, cardiovascular disease, and kidney disease [1]. Keeping daily blood glucose values within the target range also reduces short-term risks for hypoglycemia, hyperglycemia, depression, and other unfavorable outcomes [1,4,5]. However, research indicates that many individuals with T1D, and especially adolescents, do not maintain an optimal level of glycemic control, as defined by the American Diabetes Association [6]. This is related to hormonal changes during puberty and to declines in adherence during adolescence [7-9].

As such, numerous experts have cited a need for increased attention and efforts to boost adolescent adherence [3,8]. Several authors have cited opportunities to use commonly available technologies in these intervention efforts [10-13], particularly given the high penetration of mobile technologies among US adolescents [14,15]. Adolescents with T1D and their parents may already be turning to technology to support diabetes self-management [16]. In fact, there has been a dramatic rise in digital platforms and programs aimed at assisting diabetes self-management, such as mobile phone apps, websites, and groups on social networking sites (such as Facebook and Twitter). For example, as of February 2015, entering "diabetes" into the iTunes app store yielded over 1100 unique results. Yet, despite the number of apps, the evidence base for their adoption and efficacy is lacking [17].

Many technologies offer readily available means for acquiring information on demand, communicating with parents and others, and obtaining feedback on blood glucose patterns [16]. Parents' use of technologies for diabetes care or information may also be important, as research indicates that parents' technology use is often predictive of adolescents' parallel behaviors [18], and that parental monitoring and involvement in youth T1D care predicts adolescents' diabetes self-management and glycemic control [19-22]. Given the penetration of a variety of digital communication channels and technologies, it is reasonable to expect that adoption of common technologies for diabetes self-management is prevalent among adolescents with T1D and their families.

However, despite increased access to digital resources, little is known regarding how many adolescents with diabetes make use of diabetes-specific technologies or what relationships exist between use and adolescents' self-management behaviors and glycemic control. Given the lack of information on the prevalence or role of technology use in pediatric T1D, it is especially important to look at patterns associated with individual technologies, as they may be used by different subsets of adolescents with T1D and/or be uniquely linked to self-management behavior or glycemic control.

This study examined the use of 5 commonly available technologies for diabetes among adolescents with T1D and their parents. The main aim of the study was to identify the proportions of adolescents and parents who adopt each technology and the number of different technologies they use for diabetes. In addition, analyses investigated the reasons adolescents report for using or not using various technologies for diabetes, and whether demographic, parental, and clinical factors correlate with their use of each technology. A final aim was to identify whether the different types and/or number of technologies that adolescents use for diabetes were related to self-management and glycemic control.

Methods

Sample and Procedures

Recruitment took place within a large regional pediatric diabetes clinic in an academic medical center and through the Children with Diabetes community website. Children with Diabetes (CWD) is an organization that provides Web-based and face-to-face support and education for young people living with T1D and their parents. Adolescents were eligible for the study if they had been diagnosed with T1D for at least 6 months, were between 12-17 years of age, had no cognitive or sensory impairments that would prevent completing a questionnaire, and had access to the Internet.

Potential pediatric diabetes clinic participants were identified through electronic medical records. Parents of all potentially eligible adolescents seen in the diabetes clinic were identified through medical records and initially contacted through a letter sent home inviting participation for themselves and their child (n=485). Of those, 166 (34.2%) completed the survey. A Web

address for consent and a Web-based questionnaire was provided in the letter. For CWD, a banner ad and a Web link were provided on the CWD website. Parents who used the hypertext link (n=57) and completed questionnaires through the CWD website received a follow-up telephone call from research staff to confirm their child's diagnosis of diabetes. Data from families that could not be contacted by telephone to confirm the diagnosis were excluded from analyses (n=21). For both recruitment settings, once a parent had completed Web-based consent the questionnaire URL was sent to their child in an email or text message. Parents completed questions regarding demographics, child clinical information, and technology access and use. If interested, the adolescent was then able to assent and completed the Web-based questionnaire. Study data were collected using the Research Electronic Data Capture (REDCap) [23]. The Web-based survey was closed once the study met recruitment goals (n=174).

Measures

Survey Development

Standardized measures were used whenever possible, but were not available for assessing adolescents' and parents' use of technology for diabetes. In order to address this area, a multidisciplinary team of diabetes professionals (pediatric psychologist, nurse practitioner, pediatric endocrinologist) constructed applicable items. All items were pilot tested with 5 parents and 5 adolescents with T1D to confirm readability, comprehension, and content coverage.

Demographic and Clinical Characteristics

Parents reported their number of years of education and marital status. Parents also reported adolescents' age, gender, and race/ethnicity. Median household income was obtained using patient addresses and data from the US Census American Community Survey [24]. Household income was a continuous variable (values ranged from $12,500 to $236,000). Each parent reported the age at which the adolescent had been diagnosed with T1D and whether s/he used an insulin pump.

Diabetes Self-Management

The Self-Care Inventory-Revised (SCI-R) was used to measure adolescents' self-reported diabetes management behavior. The 15-item SCI-R questionnaire has demonstrated internal consistency and predictive validity for A1C [25-27]. Content focuses on a variety of daily self-care tasks such as blood glucose monitoring, insulin dosing, and food choices, as well as behaviors, such as wearing a diabetes bracelet. Participants rated how frequently they performed self-management tasks in the past 1-2 months on a 5-point Likert scale (from 1 = "Never" to 5 = "Always"). Items were averaged and converted to a 0-100 point scale, where higher values represented better self-care [25]. Cronbach alpha was 0.78 in this study.

Access to Technologies

Each parent completed items related to the adolescent's access to technologies in the home (desktop or laptop computer, tablet device), their own mobile phone, and their child's mobile phone.

Adolescent Technology Use

Adolescents completed items that assessed their use of social networking (in general and for diabetes; eg, Facebook, Twitter), diabetes-focused websites, mobile diabetes apps, text messaging communication about diabetes, and software with a blood glucose meter or insulin pump. The survey first asked whether adolescents used the technology at all for diabetes (yes/no), and then a follow-up item asked users to indicate their frequency of use of that technology for diabetes in the past 3 months (from "not at all" to "everyday").

Technology use for diabetes was examined both as the number of technologies used and frequency of use. For the number of technologies used, we created a summative adolescent index for use of technologies for diabetes using 5 items with dichotomous response options (yes/no). The items were the following: use of social networking for diabetes, visiting diabetes websites, use of mobile diabetes apps, text messaging for diabetes, and use of software associated with the insulin pump and/or glucometer. Each yes was scored 1; the possible score range for the index was 0-5.

Parent Technology Use

Parents reported their use of common technologies in general and in the context of their children's diabetes care (with the exception of glucometer/insulin pump software). With regards to Web-based social networking and apps, parents were first asked if they used these at all. Parents who reported use of the technology were then asked whether they used the respective technology (yes/no) for their children's diabetes care (eg, "Do you use apps focused on diabetes?"). Parents were also asked whether they "visit websites that focus on diabetes" (yes/no), and, within the past 3 months, whether "[my child] texts his/her blood glucose numbers [to me]." A summative index of parents' use of technologies for diabetes was created out of these 4 dichotomous items (ie, index ranges from 0 to 4).

Reasons for Using or Not Using Technology

For 4 of the technologies, adolescents who reported using each technology responded to 6 items regarding possible reasons for that use. On a 5-point scale from "strongly disagree" to "strongly agree," participants indicated whether each technology (1) "helps me to better understand how to take care of diabetes"; (2) "helps me to keep my blood sugar numbers in the target range"; (3) "helps me to solve problems related to diabetes"; (4) "helps me share specific information, like blood glucose values, with other people"; (5) "lets me help other people with diabetes"; and (6) "helps me to feel better about living with diabetes." These questions were not asked with regards to text messaging, which is markedly different from the other technologies, because questions regarding text messaging as "helping" with blood glucose values were confusing to adolescents. Dichotomous variables indicating agreement (yes or no) were created by coding responses of 4 (agree) and 5 (strongly agree) as 1, and responses of 1 (strongly disagree), 2 (disagree), and 3 (neutral) as 0.

Adolescents were asked how they used text messaging for diabetes via a single "select all" item. Six possible uses as well as an open-text "other" option were provided. The 6 options

were (1) text a parent or family member blood glucose levels, (2) get diabetes reminders from a family member, (3) text about diabetes to friends, 4) text a member of my diabetes care team, (5) get supportive messages from family or friends, and (6) get automated messages about diabetes.

If adolescents reported not using a technology for diabetes, they were asked an open-ended question regarding why: "What would you say is the main reason you haven't used 'X' in the last 3 months for diabetes?" Short answers were categorized by 1 author and 1 research assistant. No discrepancies in categorizing responses were noted. Response rates for these open-text questions do not reflect the total number of adolescents who reported not using a technology because responses to open-text questions were not required in the survey system.

Glycemic Control

Medical records were reviewed to obtain A1C values within 3 months before or after completing the Web-based questionnaire. Thus, A1C data were available for participants from the diabetes clinic, but not for participants recruited through CWD. Adolescent A1C was measured with the DCA Vantage Analyzer (Range: 2.5% to 14%, Siemens Healthcare Diagnostics Inc.).

Analytic Approach

Descriptive analyses were used to examine the distribution frequencies of use of each technology for diabetes, to examine frequencies of diabetes technology index scores, and to examine the distribution of adolescents' endorsements of possible reasons for using each technology.

This study was exploratory in nature. With no prior effect size estimates available for study variables, we attempted to detect small correlational effect sizes. The sample size needed to detect a correlation coefficient of .20 was calculated as n=153 with Type I error rate .05 and power at .80.

Logistic regression analyses tested associations between demographic, clinical, and parent variables, and use or nonuse of each of the 5 technologies for diabetes. To determine relationships between demographic, clinical, and parent technology-use variables and adolescents' scores on the diabetes technology index, multiple linear regression was used. All independent variables were entered simultaneously in these logistic and linear regression analyses.

Finally, multiple linear regression models were constructed examining relationships between use of each type of technology and adolescents' self-management behavior (SCI-R score), and adolescents' most recent A1C value, respectively. Six regression models were constructed for each of the 2 dependent variables (SCI-R and A1C). This was done to reduce multicollinearity threats and examine relationships between the individual technologies with each dependent variable. Each model contained the demographic, clinical, and parent technology covariates that were significantly related to either dependent variable. In each respective model, adolescent technology-use variables were entered individually as independent variables, without the other technology-use variables. For example, the first model contained a dummy variable representing whether adolescents use social networking for diabetes (yes = 1). All statistical analyses were completed using SPSS version 22.

Results

Sample Characteristics

Means for demographic and clinical variables are in Table 1. Values are provided for the entire sample and for 2 subsamples recruited in different settings. The participants recruited through the CWD website had a broad geographical distribution with no particular geographic emphasis. The subsample of participants recruited through CWD had higher household income, duration of diabetes, and greater insulin pump use. The subsamples (ie, recruited through CWD and the clinic) were combined for subsequent analyses.

Table 1. Sample and subsample characteristics.

		Mean (SD) or n (%) Full sample (n=174)	Mean (SD) or n (%) Clinic (n=134)	Mean (SD) or n (%) CWD (n=40)	*P* value
Parent education, n (%)					.17
	Less than high school	3 (1.7)	3 (2.2)	0 (0)	
	High school	49 (28.2)	41 (30.6)	8 (20.0)	
	2-year college	24 (13.8)	20 (14.9)	4 (10.0)	
	4-year college	62 (35.6)	41 (30.6)	21 (52.5)	
	Master's	30 (17.2)	25 (18.7)	5 (12.5)	
	Doctoral or JD/MD	6 (3.4)	4 (3.0)	2 (5.0)	
Household income (thousands of dollars)		65.2 (34.5)	60.6 (27.8)	80.5 (48.4)	.001
Married, n (%)		140 (80.5)	107 (79.9)	33 (82.5)	.48
Adolescent age (years)		14.47 (1.65)	14.52 (1.69)	14.30 (1.52)	.43
Adolescent gender, n (% male)		76 (43.7)	61 (43.7)	15 (43.8)	.99
Adolescent race, n (%)					.30
	White	149 (85.6)	113 (84.3)	36 (90.0)	
	African American	17 (9.8)	14 (10.4)	3 (7.5)	
	Asian/Pacific Islander	3 (1.7)	2 (1.5)	1 (2.5)	
	Hispanic	7 (4.0)	7 (5.2)	0 (0)	
Duration of diabetes (years)		5.83 (3.53)	5.47 (3.59)	7.02 (3.01)	.01
Use insulin pump, n (% yes)		108 (62.1)	77 (57.5)	31 (77.5)	.02
Self-management (SCI-R)		3.89 (0.49)	3.88 (0.49)	3.95 (0.46)	.41
Medical record A1C		N/A	9.03 (1.91)	N/A	N/A

Technology Access and Use

Nearly all adolescents had access to a home laptop or desktop computer (97.7%, 170/174) and mobile phone (94.3%, 164/174), with 11% (18/164) sharing their phone with another family member. Of those with access to a mobile phone, 74.4% (122/164) used a smart phone. More than 60% of adolescents in this sample used social networking (62.6%, 109/174). As shown in Table 2, the technology most commonly used for diabetes among adolescents in this sample was text messaging (52.9%), followed by mobile apps (44.8%), and pump/meter software (43.7%). Adolescents on an insulin pump reported high rates of pump/meter software use (50.9%, 55/108) compared to those who did not use a pump (31.8%, 21/66). The least commonly used technologies for diabetes were social networking (27.6%) and websites (24.7%). Among parents, the most commonly used technology for diabetes were websites (60.9%, 106/174), followed by mobile apps (32.8%, 57/174), text messaging with their adolescent about blood glucose (28.2%, 49/174), and social networking (27.6%, 48/174).

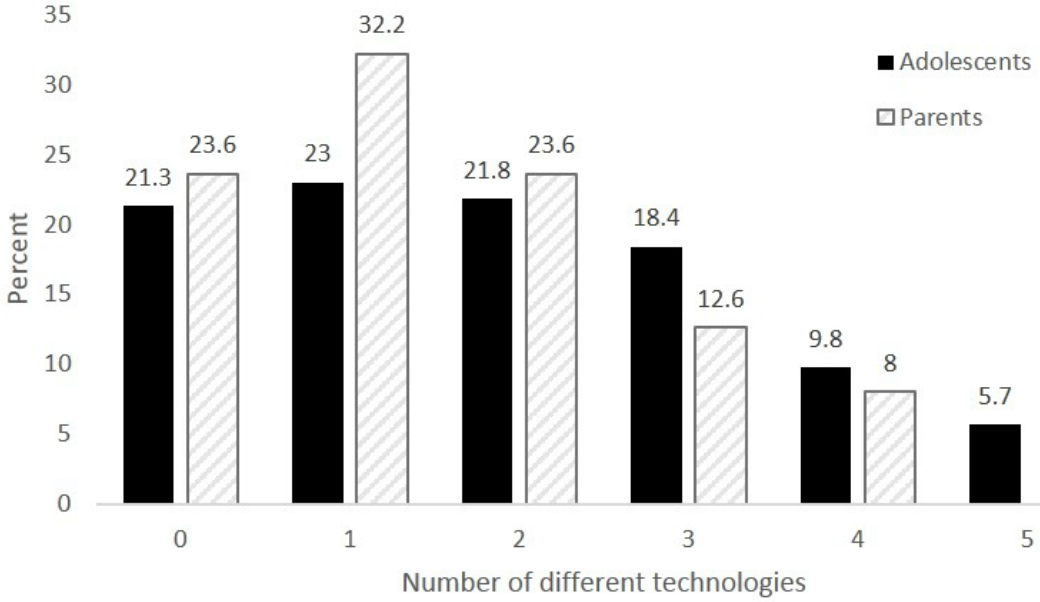
Among adolescents who used social networking for diabetes, the frequency of use reflected a fairly even distribution across the categories (from less than once a month to 4 or more times per week). Adolescents who consulted websites about diabetes tended to do so infrequently, as 65% of diabetes website users reported using these websites once a month or less. Adolescents who used apps, text messaging, and pump/meter software for diabetes tended to do so with greater frequency. Of those adolescents who used a given technology, more than 50% of users reported using the respective technology twice a week or more (see Table 2).

Table 2. Percentages of technology use and frequency of use for diabetes among adolescents who reported using a technology more than "not at all."

		Frequency of use					
	Use at all n (%)	Over one time/month n (%)	One time/month n (%)	Two times/month n (%)	One time/week n (%)	Two to three times/week n (%)	Over four times/week n (%)
Social networking	48 (27.6)	8 (16.7)	8 (16.7)	7 (14.6)	5 (10.4)	12 (25.0)	8 (16.7)
Websites	43 (24.7)	16 (37.2)	12 (27.9)	7 (16.3)	5 (11.6)	1 (2.3)	2 (4.7)
Mobile apps	78 (44.8)	15 (19.2)	5 (6.4)	3 (3.8)	9 (11.5)	9 (11.5)	37 (47.4)
Text messaging	92 (52.9)	4 (4.3)	4 (4.3)	11 (12.0)	16 (17.4)	15 (16.3)	42 (45.7)
Meter/pump software	76 (43.7)	13 (17.1)	14 (18.4)	4 (5.3)	7 (9.2)	1 (1.3)	37 (48.7)

The mean score on the adolescent diabetes technology index indicated that on average adolescents used approximately 2 (1.9) of the 5 technologies for diabetes purposes (SD = 1.5, median = 2.0). As shown in Figure 1, there was fairly even distribution across the 5 possible scores. Similarly, parents varied widely in the number of technologies they used in the context of their child's diabetes care. On average, parents reported using 1.5 of the 4 technologies for diabetes (SD = 1.2).

Figure 1. Number of different technologies teens and parents use for diabetes.



Reasons for Using or Not Using Technology

The top reasons for technology use for diabetes varied by technology. The distributions of "agree" or "strongly agree" responses by technology are displayed in Figure 2. Among adolescents who used social networking for diabetes, the most common reason (75.0%, 36/48) for use was that it let them help other people with diabetes. The most common reasons provided for not using social networking for diabetes (n=61 responses) were the following: no need or no problem (21.3%, 13/61), don't want to talk about diabetes (18.0%, 11/61), no time (14.8%, 9/61), no friends with diabetes (11.5%, 7/61), and social networking is not for diabetes (9.8%, 6/61).

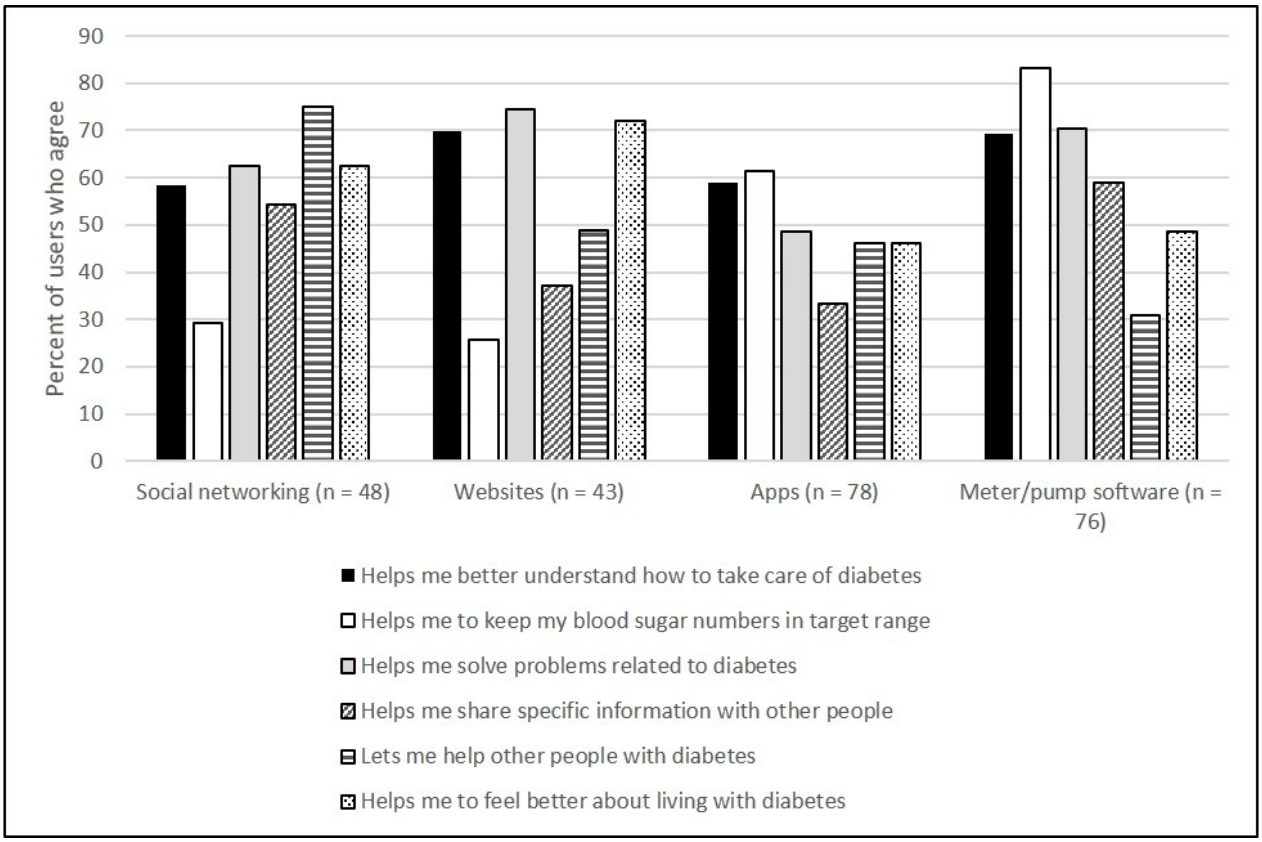
Among users of diabetes websites, 74.4% (32/43) agreed that websites helped them solve problems related to diabetes, and 72.1% (31/43) agreed that websites helped them feel better about living with diabetes. If an adolescent did not visit diabetes websites the top reasons noted were the following (n=129 responses): no need (24.8%, 32/129), didn't know of any websites (10.9%, 14/129), used other resources (10.9%, 14/129), or were too busy (8.5%, 11/129).

Adolescents reported that diabetes mobile apps were most commonly used to help keep blood glucose values in range (61.5%, 48/78) and help learn how to take care of diabetes (59.0%, 46/78). If an adolescent did not use mobile diabetes apps they most commonly reported that it was because of the following (n=96 responses): not knowing any apps (20.8%, 20/96), not liking available apps (14.6%, 14/96), no need (14.6%, 14/96), or not wanting to use a diabetes app (6.3%, 6/96).

The largest proportion of adolescents who used their meter/pump software indicated that this technology primarily helped them keep blood sugar numbers in target range (83.3%, 65/78) and helped them solve problems related to diabetes (70.5%, 55/78). The most common reasons for not using the meter or pump

software (n=51 responses) included the following: too complicated (19.6%, 10/51), don't know how (15.7%, 8/51), no need (11.7%, 6/51), don't have it (11.7%, 6/51), and unaware it existed (9.8%, 5/51). Reasons for using diabetes-related text messaging included the following: sending parent(s) blood glucose values (91.3%, 84/92), texting a friend about diabetes (34.8%, 32/92), and obtaining general support from family and friends for diabetes (20.7%, 19/92).

Figure 2. Percent of adolescents who endorsed each reason for using the technology as "agree" or "strongly agree."



Demographic and Clinical Correlates of Technology Use

Logistic regression models assessed relationships between demographic, clinical, and parent technology-use variables and adolescents' reported use of each technology for diabetes. For each dependent variable except pump/meter software, parents' use of the respective technology was entered as an independent variable. The results of these analyses are displayed in Table 3, and show a mix of demographic, clinical, and parent technology-use relationships with adolescents' use of each technology for diabetes. Adolescent age was positively associated with use of social networking for diabetes (B=0.28, SE=0.14, *P*=.047). Female adolescents were more likely than males to report using diabetes websites (B=0.89, SE=0.39, *P*=.02). With regards to clinical variables, the more recent an adolescent's diagnosis, the more likely s/he was to use diabetes apps (B=-0.14, SE=0.06, *P*=.01). Adolescents on an insulin pump were more likely to use pump/meter software (B=0.76, SE=0.35, *P*=0.03) and social networking (B=1.74, SE=0.58, *P*=.003). Across models, 2 parent technology-use variables had significant relationships with adolescents' technology use for diabetes. Parents who used text messaging with their adolescents for diabetes care were more likely to have adolescents who reported using text messaging for diabetes (B=2.30, SE=0.49, *P*<.001), and parents who used apps for diabetes were more likely to have adolescents who also used apps for diabetes (B=1.33, SE=0.37, *P*<.001).

The next analysis examined relationships between demographic, clinical, and parent technology-use variables and the number of different technologies (0-5) adolescents used for diabetes (eg, the adolescent diabetes technology index). In this analysis, parent score on the parent technology for diabetes index was entered as an independent variable, rather than parents' use of individual technologies. The overall model was significant ($F_{9, 164} = 4.90$, *P*<.001) and predicted 17% of the variance (adjusted $R^2 = 0.17$). Adolescents who used insulin pumps reported using more technologies for diabetes on average (B=0.52, SE=0.23, *P*=.03; beta=.17), as did adolescents of parents who used more technologies for diabetes (B=0.44, SE=0.09, *P*<.001; beta=.36).

Table 3. Logistic regression models predicting adolescent use of each technology for diabetes.

		Social networking		Diabetes websites		Diabetes apps		Text messaging		Meter/pump software	
		B (SEB)	OR[a] (CI)	B (SEB)	OR[a] (CI)	B (SEB)	OR[a] (CI)	B (SEB)	OR[a] (CI)	B (SEB)	OR[a](CI)
Demographic variables											
	Parent education	-0.06 (0.19)		0.06 (0.17)		-0.11 (0.15)		0.07 (0.16)		0.02 (0.11)	
	Household income	0.01 (0.01)		-0.001 (0.01)		0.004 (0.01)		0.002 (0.01)		-0.004 (0.01)	
	Parents married	0.03 (0.66)		-0.18 (0.52)		0.01 (0.46)		-0.06 (0.48)		0.33 (0.45)	
	Adolescent age	0.28 (0.14)[b]	1.33 (1.00-1.75)	0.16 (0.12)		0.13 (0.11)		-0.19 (0.12)		0.02 (0.11)	
	Adolescent is female	0.76 (0.43)		0.89 (0.39)[b]	2.43 (1.13-5.22)	0.48 (0.35)		0.12 (0.35)		-0.17 (0.32)	
	Adolescent is non-White or Hispanic	-1.13 (0.86)		-1.48 (0.79)		-0.18 (0.49)		-0.28 (0.53)		-0.40 (0.49)	
Clinical variables											
	Duration of diabetes	-0.001 (0.06)		0.001 (0.06)		-0.14 (0.06)[b]	0.87 (0.78-0.97)	0.01 (0.05)		-0.02 (0.05)	
	Uses insulin pump	1.74 (0.58)[c]	5.70 (1.82-17.9)	0.17 (0.42)		0.08 (0.37)		0.69 (0.39)		0.76 (0.35)[b]	2.14 (1.07-4.29)
Parent tech variable											
	Parent uses respective technology for diabetes	0.48 (0.45)		0.56 (0.43)		1.33 (0.37)[d]	3.78 (1.83-7.83)	2.30 (0.49)[d]	9.95 (3.85-25.76)	—	—
Nagelkerke R^2		0.25		0.11		0.18		0.32		0.06	

[a]OR represents the odds ratio pertaining to adolescents' use of the respective technology for diabetes (use=1); odds ratios are only included for significant independent variables.

[b]$P<.05$

[c]$P<.01$

[d]$P<.001$

Technology Use and Self-Management

Multiple linear regression models were constructed to assess individual technology use for diabetes and number of technologies used for diabetes as they related to adolescents' diabetes self-management (SCI-R) or A1C. For each of the 2 dependent variables, 6 regression models were created (ie, one containing each of the 5 technologies as a predictor, and one with the adolescent technology index). All models contained the demographic, clinical, and parent technology-use covariates found to have a bivariate relationship with either dependent variable, which included household income, adolescent age, adolescent race/ethnicity as something other than non-Hispanic White (dummy variable), and adolescents' duration of diabetes.

Table 4 shows that adolescents' use of 3 technologies for diabetes were each related to higher (better) SCI-R scores, including the following: social networking (beta=.18, P=.02), websites (beta=.15, P=.046), and pump/meter software (beta=.15, P=.04). In addition, the greater the number of technologies adolescents reported using for diabetes care the higher their SCI-R score (beta=.23, P=.003). In analyses with A1C as the dependent variable, adolescents who reported using diabetes websites tended to have higher A1C values, indicating worse glycemic control (beta=.22, P=.01).

Table 4. Relationships between technology use for diabetes and adolescent self-management and glycemic control.

	SCI-R[a]		A1C[b]	
	B (SEB)	Beta	B (SEB)	Beta
Household income	0.001 (0.001)	.08	-0.02(0.01)[c]	-.21
Adolescent age	-0.05 (0.02)[c]	-.18	0.20 (0.10)	.18
Adolescent is non-White	-0.18 (0.11)	-.13	1.13 (0.44)[c]	.21
Duration of diabetes	0.01 (0.01)	.08	0.05 (0.05)	.09
Uses social networking	0.19 (0.08)[c]	.18	0.62 (0.38)	.14
Uses diabetes websites	0.17 (0.08)[c]	.15	0.95 (0.35)[d]	.22
Uses diabetes apps	0.12(0.08)	.12	0.26 (0.32)	.07
Uses text messaging	0.10 (0.07)	.11	-0.20 (0.31)	-.05
Uses meter/pump software	0.15 (0.07)[c]	.15	0.19 (0.31)	.05
Adolescent diabetes technology index	0.07 (0.02)[d]	.23	0.17 (0.11)	.13

[a]Self-Care Inventory-Revised; SCI-R model adjusted R^2 values ranged from 0.05 (text messaging) to 0.08 (technology index).

[b]Glycosylated hemoglobin; A1C adjusted R^2 values ranged from 0.14 (apps) to 0.18 (websites).

[c]$P<.05$

[d]$P<.01$.

Discussion

Principal Findings

A primary goal of this study was to provide technology adoption rates for diabetes in adolescents with T1D and their parents. A recent study indicated relatively high use of Internet sources (social networking, websites, and message boards) for diabetes information among parents of children with T1D [28], but to our knowledge this is the first investigation of adolescents' adoption of commonly available technologies for diabetes. Most adolescents with T1D and their parents reported using at least one commonly available technology for diabetes. Parents and adolescents showed differing patterns of technology use, with teens using text messaging predominantly and parents using diabetes websites. Each of the 5 technologies was used by at least one quarter of adolescents for diabetes purposes. The 3 technologies adopted by the greatest proportions of adolescents for diabetes —text messaging, diabetes apps, and pump/meter software—were also the technologies used most frequently by users (ie, 4 or more times per week). That is, if those technologies were used, they were used frequently. Many participants used at least two technologies for diabetes (56% of adolescents and 44% of parents). However, just under one quarter of the sample did not use any of the technologies for diabetes.

Diabetes-related social networking had a relatively low rate of adoption (~24%). Adolescents reported using social networking primarily because it allowed them to help others with diabetes. Adolescents also commonly reported that social networking helped them to solve problems and feel better about living with diabetes. The reasons provided for not using social networking for diabetes revealed beliefs that one had to disclose a problem in order to bring up diabetes on social networking sites, avoidance of communication with peers about diabetes, the desire to have others with diabetes on the social network, and beliefs that social networking is not intended for or optimized for discussion about diabetes. The integration of popular social networking sites into adolescent chronic health behavior programs will need to address these needs and beliefs. There is little research focused on use of social networking in this population. These results imply that a closed community, safe environment, and minimization of potentially negative consequences of publicly discussing diabetes will likely provide a solid basis for leveraging the potentially positive aspects of social networking such as receiving positive feedback and social support, and sharing diabetes coping and self-management strategies [29-31].

Similarly, adolescents used diabetes websites relatively less than other technologies (~25%). The most common reasons cited for using them included solving diabetes problems, feeling better about living with diabetes, and understanding how to take care of diabetes. When diabetes websites were not used at all, it was typically because adolescents' believed that they did not need them, did not know of any websites for diabetes, or used other resources. Features common to diabetes websites available to adolescents included a forum for questions and answers, integration with social networking, and news articles or blogs [32]. It is possible that these website features were perceived as largely taken care of through other technologies or resources. Additionally, although websites are available via mobile phones, they may not be viewed or accessed as a mobile resource compared to mobile "apps" with functional components.

Mobile diabetes apps were used by a significant portion (~40%) of the sample. Diabetes apps were used specifically for managing blood sugars with low rates of use for other functions such as communication with others. This is consistent with recent research documenting diabetes app features primarily

focused on blood glucose tracking and management [17,33]. The majority of adolescents did not use diabetes apps at all due to not knowing about them, not liking their choices, or not feeling the need to use them. Reasons for not using apps for diabetes point to the need for a mobile intervention evidence base and the integration of adolescents in the design and testing of those tools. These processes will result in a scientific rationale upon which clinicians may recommend mobile apps in routine care and apps that are engaging to adolescents.

Text messaging was used most frequently by adolescents for diabetes compared to the other technologies (~53%). Adolescents primarily used text messaging for communicating blood glucose values with family and for general communication with friends about diabetes. Meter and pump software were also one of the most frequently used technologies (~44%). Not surprisingly, adolescents using an insulin pump used the software most often. One possible reason for the software adoption rate is the bolus wizard function, which may be used up to several times per day. This feature assists in calculating insulin dose but is not required. The reasons for not using software associated with a meter or pump revealed that the majority found the software difficult to use or had not been educated about how or why to use it.

Adoption of the respective technologies was associated with varying demographic, clinical, and parent technology-use variables but did not show strong relationships across technologies. Age, duration of diabetes, and insulin pump use, while related to use of a single technology, did not show robust relationships. Across technologies, use was not associated with socioeconomic status variables. Access to technologies was quite high and overall, socioeconomic status did not appear to impact the frequency of technology use in this sample. However, as with many studies of pediatric T1D, this sample had somewhat reduced variability in income, education, and race. That may have impacted the ability to establish a relationship with those variables.

Adolescents who reported using social networking, websites, and glucometer and/or pump software had better self-reported self-management compared to nonusers. Although their features and purposes vary, more than 60% of adolescents who used each of these 3 technologies for diabetes agreed that these helped them to solve diabetes-related problems. Problem solving skills are consistently related to better self-management in cross-sectional and interventional diabetes research [34-37]. Problem solving value may be a critical determinant of whether or not a given technology is adopted or viewed as helpful for self-management. Next steps for this research will document the specific problems identified and/or solved using these technologies.

Interestingly, use of text messaging and mobile apps, the 2 technologies that did not show relationships with self-management, were the most commonly used technologies for diabetes. While the reasons endorsed for using these technologies could logically relate to improved self-management, it may be that unhelpful modes of use may be counteracting each other or that use is too unstructured and does not translate to improving specific behaviors such as blood glucose monitoring or insulin administration. For example, adolescents reported texting friends almost as frequently as parents. In and of itself, communicating about diabetes more frequently using that technology did not appear to relate to better self-management practices.

The use of more technologies, assessed via the technology index, was positively related to self-management. One possible reason for this is that adolescents who use more technologies in the context of their diabetes care may be more diligent in general about managing their disease. As mentioned above, different technologies may also fulfill different diabetes-related needs, and thus using several technologies could support adolescents in more ways than can be accomplished using a single technology. Alternatively, there may be a general orientation toward technology among some adolescents that facilitates the integration of multiple technologies into everyday diabetes problem solving. Although diabetes is associated with a relatively technology-heavy self-management regimen, no research has identified a general orientation toward or adoption of technology in general as related to better levels of chronic illness health behaviors or outcomes. A significant portion of the sample perceived each technology as useful for diabetes. These results will provide the basis for development of an adolescent health technology adoption model. Variables such as motivations for information seeking, problem solving orientation, perceived usefulness, and ease of use will need exploration as part of the model development [38].

While use of several technologies was associated with more favorable self-management, technology use of any kind did not translate into better glycemic control. Although self-management is critical for glycemic control, relationships with self-management were not robust. Adolescents who reported using websites for diabetes had higher A1C values than those who did not. It is possible that adolescents struggling with glycemic control may be drawn to diabetes websites for tips or self-management aids. Overuse of technologies amongst a small portion of adolescents may have an inherent risk as well, with some research indicating the highest frequency users are not those with the best health behaviors [39]. Further research examining the content of technologies adolescents consult for diabetes-related purposes, subsets of adolescents who overuse technologies, as well as their motivations for consulting those technologies are needed to illuminate mechanisms behind these relationships.

Limitations

This is the first study to document adoption and reasons for use of technology in adolescents with T1D and relate use of those technologies to self-management and glycemic control. However, several limitations of the study should be noted. Some items related to frequency and purpose of technology use needed to be created as they did not exist in the scientific literature. As we did not conduct an observational study to identify content transmitted and technology features used, the mechanisms of the reported relationships are unknown. While meter/pump software has a relatively limited set of uses, content, and communication capabilities, other technologies are more varied in their features. For example, the lack of a relationship between

text messaging for diabetes and self-management may reflect the many potential ways that technology may be used and suggests that the nature and quality of family communication around a child's T1D may be more important than frequency and mode of communication [40]. Qualitative and longitudinal research is needed to determine the nature of use and identify potential mechanisms underlying relationships with self-management.

These data are cross-sectional, and it is not possible to determine the direction or nature of causality in identified relationships. The technologies may be used routinely regardless of varying diabetes circumstances, proactively to prevent worsened self-management, or reactively to address problems. As there were no standardized measures of diabetes-related use of technologies, we needed to create those items. Finally, given the novel and exploratory nature of the study, the relationships suggested here and derived from multiple significance tests should be confirmed in follow-up research.

Conclusion

These findings have implications for clinicians and researchers designing interventions targeting adolescent adherence and for parents of adolescents with T1D. The majority of adolescents with T1D have access to digital technologies, and most are using at least one technology as a resource for their diabetes self-management. However, it appears that a significant minority are not oriented at all toward technologies for diabetes self-management. Many did not know about the technologies, did not see their value, did not need them, and/or simply were not interested. This may be related to the lack of an established body of literature linking them to improved outcomes, which in turn may result in little promotion of technologies by clinicians for diabetes care. Even so, not every website or mobile app will have an evidence base and are unlikely to be incorporated into clinical practice. The broad uptake of technologies such as mobile apps will depend on a patient-centered development process, a rigorous evidence base, and social marketing of a few good products. Even then, the use of many technology resources alone does not seem to be strongly tied to better self-management. As Borus (2013, p. 2) contends, "…technology without support to help manage the opportunities it provides is not the answer" [40]. For young people, guidance on their use will be important and integration into a comprehensive set of learning supports and experiences will enhance engagement and efficacy.

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Conflicts of Interest

None declared.

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Abbreviations

A1C: Glycosylated hemoglobin
T1D: Type 1 diabetes

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