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Evaluation of Satisfaction and Use of Electronic Intervention for Behavior Change

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Abstract

This report describes use and satisfaction of a tailored intervention delivered via Web site and handheld computer. All participants used both delivery methods. Healthy women (N = 74) aged 40 to 60 years participated in this mixed-method descriptive study. Satisfaction was measured via Computer Satisfaction Questionnaire and open-ended comments. Data on use of the handheld computer were embedded into program and captured real time. Unique Internet provider addresses tracked Web site use from March 2007 through August 2008. Results indicate 80% of participants were very to extremely satisfied. There was no significant relationship between use and satisfaction. Knowledge but not self-efficacy scores differed over time. Usage was not related to knowledge scores. Handheld computer was used most frequently during the first week, with use decreasing over 7 weeks. Personal assessment of calcium intake and feedback sections were used most frequently. Handheld computer was used by 71% of participants for 4 weeks, 55% for 6 weeks, and 29% for the full 8 weeks. Participants commented on intervention content and positive and negative aspects of the devices and keyboard. This study presented an opportunity to examine data related to actual use. This dimension of intervention fidelity is more readily available in eHealth applications than with printed information.

Keywords

Bone health; eHealth intervention; Intervention satisfaction; Intervention use; Self-management; Women and computers

Interventions facilitating health behavior change are affected by numerous factors including health conditions, patient and family preferences, professional expectations for increasing patient responsibility, social acceptances, economic resources, and availability.^{1,2} Although once effective, many traditional delivery methods are no longer meeting the preferences and needs of patients or the demands of the healthcare system.^{3–6} New interventions and delivery methods need to be designed, and their effectiveness tested. eHealth interventions have a number of potential advantages including the abilities to reach a large number of

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persons, provide self-paced learning, and complement professional care. For electronic interventions to maintain or improve health outcomes, they must be satisfying to and used by persons. Satisfaction with and use of electronically delivered interventions are just beginning to be understood.^{1,2,7} The relationship between the delivery method and content of an intervention is complex, and understanding the complexity is heightened when the delivery method is electronic, as little is known about electronic delivery methods in comparison to other types of delivery methods. Evaluation of the delivery method as well as content of the intervention is necessary to understand the impact of the intervention.^{1,8} The purpose of this article was to describe women's satisfaction with and use of an electronically delivered intervention designed to promote bone health. The relationship of participant satisfaction to use, knowledge, and self-efficacy is explored.

BACKGROUND

Electronic interventions have been used for patient education since 1971.¹ Use of electronically delivered interventions is expanding into multiple areas of healthcare.^{3,4,9,10} Goals of eHealth interventions are purpose dependent and diverse including automation of tasks (clinical alerts, medication reminders), patient monitoring, documentation replacements, information gathering (monitoring behavior, use, education), and supplementation and replacement of patient education programs.^{3,4,9,11} Electronic interventions offer flexibility in the way information is displayed, accommodating multiple purposes and user experiences.^{1,9,12,13} eHealth applications include Internet Web sites, available software, interactive online discussions, and, most recently, video games with online capabilities.^{7,14–16}

The Internet has been a driving force in expansion of electronic healthcare information and interventions. Estimates of Internet connections have grown from 5 million users in 2001 to 117 million in 2007, expansion occurring in tandem with wide-scale broadband availability.^{17,18} Younger persons accept asynchronous communication, electronic solutions, and resources more readily than do older adults.^{4,19,20} Use of electronic delivery methods is negatively affected by a number of factors including low computer literacy, user distraction associated with noisy learning environments and interruptions, rigidly controlled program sequences, and program flexibility limited by lack of information depth.^{1,9}

Electronic delivery of health information is a relatively new way for persons to learn about and manage their health. Initial and long-term use of the application and mastery of content are dependent on a person's satisfaction with the electronic intervention. People dissatisfied with an electronic intervention often discontinue its use prematurely. Actual use of healthcare interventions by the intended recipient is rarely measured directly; rather, it is obtained by observation or self-report.^{9,21} Measurement of use of electronic delivery methods can be captured in real time and stored. Real-time performance data are rarely incorporated into the analysis of delivery or data.²²

Evaluation of satisfaction is commonly omitted, limited to pilot studies preceding clinical trials of effectiveness, or measured with instruments with limited reliability and validity.^{1,9,10,12,21} Three recent literature reviews compiled information about eHealth

applications focusing on mode, outcome, duration, format, learning environment, clinical benefits, and economic benefits,^{1,13,23} but not one article mentioned satisfaction. A great deal is yet to be learned about satisfaction with electronic delivery methods used to deliver health information and interventions.

In addition to being able to successfully use the delivery method, the delivery method needs to effectively deliver content. Satisfaction with and use of the delivery method can be evaluated directly,^{19,24} and use can be reflected by successful mastery of content. In this study, content mastery is examined as proxy measures of use. Use of eHealth applications may also result in improvement in outcomes, for example, knowledge and self-efficacy.

INTERVENTION

The intervention evaluated in this study was developed to enhance health behavior change, specifically increasing calcium and vitamin D intake for bone health. Usability studies were conducted before testing the effectiveness of the intervention in a clinical trial.²⁵ In the randomized clinical trial, women were randomly assigned to group and received either the brochure or the electronic intervention, which was delivered via a Web site and a hand-held computer. The electronic intervention was delivered to all participants in the experimental group via Web site and handheld computer—satisfaction with both components of this intervention was evaluated in this study. At the time the intervention was developed and tested, no single electronic device was available to deliver large amounts of tailored information in a format acceptable to women and provide the portability needed to integrate self-regulation activities into women's active lifestyles.

The electronic intervention is patient centered²⁵ and is characterized by the selection and delivery of content and processes in a manner that is respectful of and responsive to the characteristics, needs, and preferences of each person using the intervention.²⁶ The intervention is targeted to women during menopausal transition and tailored²⁷ to match their current calcium intake, perceived risk for development of osteoporosis, and their health beliefs of self-efficacy, outcome expectancy, and goal congruence. The intervention runs via two related but different electronic methods: a Web site and a hand-held computer. Both methods are used by all participants. Factual information about osteoporosis and calcium intake is primarily on the Web site, while a program specifically designed to enhance self-regulation behaviors is on the handheld computer. The handheld computer is a Dell Axim PDA (Dell, Round Rock, TX) running Windows Mobile (Microsoft, Redmond, WA). A wireless keyboard is used for data entry.

METHODS

This is a secondary analysis of data obtained from a randomized controlled trial testing differences between two interventions: one delivered electronically, and the other via brochure. This report is restricted to the electronic intervention group and is a mixed-method descriptive study with data measured during and following participant use of the 8-week intervention. A convenience sample of healthy women between the ages 40 and 60 years was recruited from an urban community in the Midwest. Women lived or worked within 30

miles of the study center, spoke and wrote English, had no previous diagnosis of osteoporosis or osteoporosis treatment, and had a dietary intake of less calcium than recommended for their menopausal status.

Measures of satisfaction, knowledge, and self-efficacy were collected via paper-and-pencil instruments. Satisfaction was measured using the Computer Satisfaction Questionnaire.²⁸ This 16-item linear scale includes responses ranging from 1 (strongly agree) to 7 (strongly disagree). The questionnaire examines several factors related to satisfaction, including simplicity of the program, participant's comfort, clarity of messages, and ease of finding needed information. Internal reliability of the questionnaire ranges from 0.90 to 0.97 in previous studies.²⁸ Open-ended comments following each of the 16 questions and responses were categorized, and frequency counts were determined using the content analysis method.^{29,30} Knowledge about osteoporosis was measured using the Facts on Osteoporosis Quiz.³¹ This 20-question true-false scale records knowledge, with correct answers receiving a score of 1 point and incorrect answers receiving 0 points. Higher scores reflect greater knowledge. In prior studies, reliability ranged from 0.92 to 0.84 in middle-aged women.

Measures of self-efficacy related to calcium and vitamin D intake were measured using the Osteoporosis Self-efficacy Scale.³² This 22-item visual analog scale was modified to exclude items related to physical activity and include items related to vitamin D intake. Scores for each item range from 0 (not at all confident) to 100 mm (very confident). Reliability for the unmodified scale varies from 0.86 to 0.92 in previous studies.

Use of the handheld computer was determined. Tracking of time within each of seven sections of the handheld computer software was recorded, along with frequency of use daily and weekly during the 8-week study period.

Participant use of the handheld computer was electronically recorded. Acquisition of data use was embedded into program design, captured real time during participant intervention use, and stored in SQL tabular format on the device. These data were then exported using Open Database Connectivity methods and a custom-written program to populate a Microsoft Access database (Microsoft, Redmond, WA). Data were exported to SPSS version 17 for statistical analysis (SPSS Inc, Chicago, IL).

The Web site was housed behind a firewall at the university, and only study participants were given access to the Web site. Prior to initiating the study, researchers worked with persons from the university information technology department to ensure the recording and retrievability of user-specific URL and time of use. Use of the Web site and retrieval of resultant data were piloted prior to initiation of the study. Web site access logs were examined, and a list of unique IP addresses was generated to track use of the Web site over the period of study from March 1, 2007, through August 15, 2008.

Data extraction from the Web site and handheld computer was tested prior to the enrollment period to ensure integrity of data. Researchers mimicked participant use of the intervention for several days, and data were extracted to ensure that meaningful data could be accurately and completely gathered.

PROCEDURE

Researchers met with women to obtain their written consent to participate in the study, complete baseline data, determine random assignment to group, and to distribute packets of information about the study and material and equipment needed to use the intervention. Women receiving the electronic intervention received instructions on both the Web site and a handheld computer. Participants were shown how to visit the Web site, complete the assessment questions leading to the tailored content, and navigate to the other sections of the Web site. They were required to demonstrate an ability to locate the study splash page from the Internet and to navigate through sections of the Web site. A copy of the intervention URL was sent to them via e-mail, and they were shown how to add the intervention as a "Favorite." A printed copy of the URL, researcher e-mail, and telephone number was included in the study folder provided to every participant. Participants were encouraged to review the content on the Web site thoroughly at least once and to use the Web site as a resource during the 8-week intervention period.

During this enrollment meeting, women received the handheld computer, keyboard, and extra batteries and written "User Tip" sheet. Researchers provided an instructional session on handheld computer use and observed return demonstration by participants. Participants were encouraged to use the handheld at least 3 days a week throughout the 8-week period, set weekly calcium and vitamin D intake goals, record their calcium and D intake, review normative and ipsitive feedback, and journal (a process facilitating reflective thinking). The handheld computer had information and tips sections available for review. At the conclusion of the 8-week period, women met with a researcher to return the handheld computer and a completed set of satisfaction, knowledge, and self-efficacy instruments.

RESULTS

The electronic intervention group contained 74 participants (Table 1). Participants averaged 50 years of age, were most commonly college graduates, lived in a partnered relationship, did not live with children younger than 18 years, and were white.

Women used both the Web site and the handheld computer. The Web site was designed to be used less frequently than the handheld computer. Analysis of Web site access logs revealed that 176 unique IP addresses were used to visit the Web site—or 176 different computers were used by the 74 participants. Five IP addresses were identified as geographically specific locations with firewall access points. A number of women participating in the study worked for large corporations providing computer access for employees' personal use. These secured IP addresses represented different computers and distinct users within these corporate locations but made it impossible to track the number of hits or users.

Handheld computer use was evaluated in a number of ways. Usage was analyzed for average number of hits per week (Figure 1), number of hits per section (Figure 2), and number of weeks used (Figure 3). Use decreased each week over time, with an exception of an increase just prior to the participant returning the computer. By week 7, women were using the

computer on an average of three times weekly. Women used the computer most frequently to enter their calcium and vitamin D intake and to receive ipsative and normative feedback. The goals section was designed for weekly use, but it appears women entered this section more frequently. A journal section was designed to facilitate self-reflection linking goals, goal achievement, and personal behaviors. The limited use suggests that this section was not used as intended. The facts and tip sections contained information about foods high in calcium and vitamin D and were used least frequently. Factual information is accessible also via the Web site. There was variability in the number of weeks the handheld was used. Handheld computer was used by 71% of participants for 4 weeks, 55% for 6 weeks, and 29% for the full 8 weeks. In general, it was used weekly until the participant stopped using it altogether, but a few participants did use the device intermittently.

The Computer Satisfaction Questionnaire had a Cronbach α coefficient of .94 and a 55% response rate for Web site satisfaction and a 93% response rate for the handheld computer satisfaction. Participants were satisfied with the Web site in general (mean, 2.59 [SD, 1.35]) and had even greater satisfaction scores with the handheld computer (mean, 2.37 [SD, 1.30]) (lower scores indicating greater satisfaction) (Table 2). There was no significant relationship between the frequency and duration of use of and satisfaction with the Web site or computer. There were differences in knowledge ($t_{61} = -6.726, P = .00$) but not self-efficacy ($t_{61} = 0.250, P = .80$) scores before and after use of the intervention. Usage was not related to knowledge scores.

Qualitatively, 27 participants made 36 unique comments. Several users were unable to find the Web site URL or were unclear what “tasks” they were expected to perform on the Web site. It is unclear if women misunderstood the meaning of the word “task” or if the purpose of the Web site was unclear. This confusion was not noted with the handheld computer.

Six participants wanted additional information or more detail. For example, one participant stated, “Not much info, read it all on first login.” Three users specifically stated that the Web site did not contain information they required to answer questions, yet content from the Web site contains over 300 pages of information in printed form. This comment raises the possibility that participants were unable to locate information on the site.

Handheld computer written feedback included 67 unique comments. Comments were both positive and negative. For example, one user stated that she “loved” the keyboard, while another stated a complete inability to operate the keyboard.

Three participants reported the Web site calculated calcium supplements incorrectly. The calculation error led to a correction by the software author early in the study. Two participants unknowingly turned the tape recorder function of the handheld computer on, resulting in low operational memory. Assistance by research staff was required to recover operational memory. Computer settings were changed to prevent this problem in the future.

Participants made anticipatory comments regarding use of the computer. For example, one participant stated, “I was nervous about exiting or trying anything beyond the initial areas—fell into a pattern of how I used.” Another user offered her perspective on apprehension in using the handheld computer: “In the beginning (first orientation session), I felt

apprehensive and wishing I would have gotten papers to complete—but after getting started, I loved it and was very pleased to have the computer.”

Participants commented on the keyboard. One woman stated, “I didn’t journal much because I just didn’t want to take the time to set up the keyboard.” Another stated, “the keyboard never worked right for me.”

Some women commented on the content of the intervention. They desired a more complete listing of foods containing calcium and expressed frustration with not being able to find all calcium-fortified products. One user stated, “Not much variance for different foods. I had to substitute lots of items, power bars, and drinkable yogurt; not enough choices. Choices were too rigid. Better if we could input our calcium level directly with no number assigned.”

DISCUSSION

The relationship between the delivery method and content of an intervention is complex. Understanding the complexity is heightened when the delivery method is electronic, as little is known about electronic delivery methods in comparison to one-to-one interactions, small groups, or paper. The delivery method of one-to-one teaching is affected by factors such as appearance, age, personality characteristics, and culture. Group dynamics and environmental factors affect satisfaction with and attendance in the small groups. Reading levels and pictures affect satisfaction and use of printed materials. Usability affects electronic interventions, but more information is needed about factors affecting satisfaction and use of electronic delivery methods.

All participants used both electronic delivery methods and the content delivered via each method differed. Participants were slightly more satisfied with the hand-held computer than the Web site. More women completed satisfaction questionnaires and commented about the handheld computer than the Web site. This could be an example of the complex relationship between delivery method and content. Perhaps women were less satisfied with the delivery method, or perhaps they were less satisfied with the content. The Web site was designed to increase the participants’ plural possessive knowledge about osteoporosis prevention and bone health and to enhance their self-efficacy. The handheld computer was designed to increase self-regulation skills and abilities. It is possible that women responded more positively to information and processes designed to help them change their health behaviors and responded less positively to delivery of cognitive information. It is equally possible that women preferred the handheld delivery method to use of desktops for access to the Web. As it is now possible to surf the Web easily using handheld devices, future research can shed light on the interaction between delivery method and content.

A number of participants did not complete the satisfaction scales, and fewer added comments. It is possible that women did not believe they had adequate knowledge about electronic interventions to complete the questionnaire or add a free-text comment. While evaluation of satisfaction is critical, perhaps the addition of alternative evaluation methods would facilitate the acquisition of richer satisfaction data. One-to-one semistructured

interviews may provide women the opportunity to talk about their experiences without needing the “right words.”

Some participants rigidly adhered to the directions and functionality of the electronic intervention, while others used the intervention with greater flexibility and made decisions based on principles rather than rules. For example, the handheld computer contained a wide selection of food for women to select from as they were recording their calcium intake—but not all calcium-containing foods. For some women, the exact product needed to be listed; for other women, if the exact product was not listed they selected a substitute food that contained an identical amount of calcium. New versions of the intervention need to better accommodate all women. In addition to teaching women how to read food labels, the intervention needs to help women understand the purpose and principles of calculating daily calcium intake.

Use of electronic interventions provides us with an increased potential to understand the relationship between intervention use (dose) and end outcomes. Rather than assuming people use an intervention as directed or accurately self-report use, electronic interventions have the capacity to provide data about the real-time use of these interventions. A great deal needs to be learned about how to make the most effective use of those data. Standards and technology need to be developed to ensure retrievability of data. Transition across servers needs to become increasingly friendly. The ability to retrieve data needs to be tested early and often. Additional knowledge is needed to determine the most meaningful units of analysis. Tabulation of “hits” provides data about the number of times a program or section of a program has been opened. Time stamps have the potential to record how long an individual remains in a program or a section of the program. What is most meaningful as research data? Hits could represent participant learning to use an electronic site or frustration in opening a section of a program in error. Is time a proxy measure of one’s productive use of content within a section? With the increasing use of electronic sites, these issues will be tested and debated, and new knowledge will emerge.

Electronically delivered interventions uniquely affect fidelity. While some scholars have been concerned that tailored interventions fail to standardize intervention delivery,²⁶ the quality of data is improving, and we will soon have data demonstrating participants’ actual reception and use of an intervention. Other methods of intervention delivery (eg, paper, one-to-one, small group) make the assumption that all persons received and used all components of the intervention. In the future, electronically delivered interventions will provide participants’ reception of and use of an intervention via “usage time.” Total usage time and the time for each section of the intervention will be electronically recorded. While the ability to log usage time is a new science and not without problems, it promises considerable insight into intervention fidelity previously reported via self-report. With minor improvements, dose of the intervention (how frequently the intervention or one of its components is used over time) can be included as a variable in analysis of the effectiveness of an intervention.³³

While some people are able to initiate and maintain health behavior change, for most persons health behavior change is characterized by a pattern of gradually decreasing use.

While this pattern has been quantitatively observed across behaviors, the use of technology, with embedded measures of use, will foster an empirical description of the patterns.^{10,34} Additionally, analysis can look at growth and deterioration curves ultimately helping to get a better notion of characteristics of the intervention that foster both initiation and maintenance of change.

LIMITATIONS

A change in university setting resulted in a shift in Web server architecture on which the Web site was hosted. While this occurred prior to initiation of enrollment, it led to difficulty in obtaining informative data from the Web site regarding usage. Despite preassessment and assurances from the host organization of the availability of information, it was not available as desired by the end of the study; hence, meaningful data about use of the Web site were not captured.

An inability to measure Web site use with the same level of granularity available for the handheld computer adds to the difficulty in determining actual use and usability of the Web site component of the intervention. Several direct participant reports of a failure to use the Web site indicate that women may not have fully understood the purpose of the Web site to serve as complementary information to the self-regulation component included in the handheld program. Advances in mobile technology and communication capabilities today might allow increasing ease of use of the two modalities into and a more cohesive application. Participant assumption that the Web site and handheld contained comparable activities in the absence of statement of this as fact and use of one of the two modalities as adequate might be avoided given the integrative properties of multimedia programming and communication methods available today.

Participant exposure to computers, the Internet, and handheld technology was not assessed in this study. Data gathered on prior experience with technology might prove useful in explaining the process of use with the handheld computer and Web site and offer more meaningful feedback regarding participant experiences if researchers were aware of participants' level of expertise.

CONCLUSION

Women liked the Web site and handheld delivery of health-related and behavioral information in this study. This study presented an opportunity to examine empirical data related to actual use, which should be considered more readily in eHealth applications. Given the opportunity, women provided useful suggestions regarding content and program design. Preliminary testing and problems discovered during implementation illustrate the need to build support resources into program and intervention design. Finally, in addition to formal evaluation of satisfaction, consideration should be given to structured interviews for women to provide feedback and voice concerns with guidance by expert users. This might allow for discovery of program use for unintended purposes and provide additional insight into the process of use for eHealth applications.

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FIGURE 1.
Handheld computer frequency use by week.

FIGURE 2.
Percent of handheld computer use by section.

FIGURE 3.
Number of weeks hand held used by participants.

Table 1

Characteristics of Participants (N = 74)

Age, mean (SD), y	49.68 (5.53)	
	Frequency	%
Race		
White	60	81.1
Other	14	18.9
Education		
High school graduate	5	6.8
Partial college	21	28.4
College graduate	33	44.6
Graduate degree	15	20.3
Living arrangements		
Partnered	50	67.6
Not partnered	24	32.4
Live with children aged <18 y		
Yes	27	36.8
No	47	63.2

Table 2

Satisfaction With Electronic Delivery Methods of the Intervention: Both Methods Used by All Participants
(Potential No. of respondents = 74)

Web Site Overall Satisfaction (41 Completed Surveys)	Handheld Computer Overall Satisfaction (69 Completed Surveys)
Strongly agree to agree, n = 35 (85%)	Strongly agree to agree, n = 57 (82%)
Neutral, n = 4 (9%)	Neutral, n = 4 (6%)
Disagree to strongly disagree, n = 2 (5%)	Disagree to strongly disagree, n = 8 (12%)
No data, n = 33	No data, n = 13

Comments	Comments
Self-report of no use, n = 10 (27%)	Computer: keyboard, software bug, error message clarity, screen delay, and recovery, n = 18 (27%)
Unclear tasks, n = 5 (14%)	Comfort, n = 11 (16%)
Informative, n = 7 (19%)	Design general: food choices—inadequate, n = 21 (30%)
Errors occurring with computer use, n = 6 (17%)	Errors occurring with computer use, n = 9 (13%)
Information—lacking, n = 6 (17%)	Fun n = 5 (7%)
Miscellaneous, n = 2 (6%)	Miscellaneous, n = 3 (5%)
No comments, n = 31	No comments, n = 24
Total comments provided ^a = 36	Total comments provided ^a = 67

^a Some individuals made more than one comment.