Design and testing of an interactive smoking cessation intervention for inner-city women

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Abstract
The purpose of this study was to design and test the usability of a computer-mediated smoking cessation program for inner-city women. Design and content were developed consistent with principles of user-centered design. Formative and summative evaluation strategies were utilized in its testing. The summative evaluation was designed to test usability in a naturalistic environment. A sample of 100 women who receive care at an inner-city community health center participated in the study. Average time for completing the computer program was 13.9 minutes. Participants reported a high level of satisfaction with usability of the program. Standardized instruments to measure cognitive processes of change related to smoking were completed at baseline and at 1 week. Participants reported a decrease in favorable attitudes toward smoking \((P = 0.014)\) and an increase in cognitive change processes at follow-up \((P = 0.037)\). These results indicate that interactive computer technology is acceptable to, and potentially useful for, promoting smoking cessation in low-income women.

Introduction
Routine smoking cessation intervention by health care providers as brief as 3 minutes can significantly increase quit rates (Fiore et al., 2000). However, studies have shown that as few as one in four smokers are advised to quit smoking by their health care providers (Jaen et al., 1998; Thorndike et al., 1998). The most common reason for this omission in primary care is the restricted time available for preventive health teaching (McBride et al., 1997). Multimedia instructional technology is an innovative and efficient method to deliver smoking cessation information in the primary care setting, and may increase motivation to quit.

Computerized patient education is becoming more common in clinical settings, yet questions about patient acceptance and degree of efficacy with naïve users persist. Systematic reviews of computer-based patient education have shown that interactive computer interventions are effective in increasing knowledge (Lewis, 2003). Patient receptivity to computerized education is reported to be high across diverse medical conditions and age groups (Revere and Dunbar, 2001). Although access to computers among low-income populations has increased (National Telecommunications and Information Administration, US Department of Commerce, 2000), little is known about the acceptability and efficacy of interactive technology for influencing behavior change in this group (Stanley, 2003).

Computer technology has been used to enhance smoking cessation by incorporating tailored information into traditional self-help materials, which have been shown to be more effective in promoting smoking cessation than non-tailored educational...
resources (Shiffman et al., 2000; Etter and Perneger, 2001; Prochaska et al., 2001). These computer interventions were used to provide written feedback to smokers over time, but were not presented in real-time (i.e. printed reports were mailed to participants at a later date) and thus did not capitalize on the ‘teachable moment’ of the primary care encounter.

Usability testing is a widely used technique to assess the utility of a system or product to accomplish a goal from the perspective of the end-user (Wichansky, 2000). Important features of an interactive program that contribute to usability include such factors as ease of learning, efficiency of use, user satisfaction and utility for which the application is intended (US Department of Health and Human Services, 2004). Usability testing is a standard process in the information technology industry (Nielsen, 1993), but may be overlooked in non-commercial software development for consumer health education. The purpose of this study was to design and test the usability of an interactive computer-mediated smoking cessation program for inner-city women.

**Methods**

**Program design and content**

The program design and content were developed using principles of user-centered design (Nielsen, 1993) and the Persuasive Health Message framework (Witte et al., 2001). According to this framework, messages must address constant and transient factors to effectively motivate health behavior change. Constant factors consist of health threat balanced with an efficacy message, structure and organization of the message, and demographic/cultural profile of the targeted audience. Transient factors vary by audience, and include salient beliefs about the perceived health threat and response efficacy.

In designing the content of the program messages, we were guided by the findings of our focus groups with women who were demographically similar to the target audience (McDaniel et al., 2002). According to these women, key issues about smoking cessation were: lack of social support, low self-efficacy for quitting, stressors associated with expectations of women and concerns about weight gain. Participants expressed a preference for learning about diagnosis and treatment options from health care professionals, but wanted information about instrumental behavior change such as going on a diet or exercising from ‘real people’.

**Program interface and navigation**

The program was designed to deliver tailored smoking cessation messages in a relevant and acceptable format, using Macromedia Director 7.0 software. All screen text was simultaneously presented in audio format to increase comprehension in lower literacy participants. The program was navigated by using a touch-screen monitor. Based on data the user entered, algorithms derived from the scientific literature on smoking cessation and behavior change determined program content and progression through a series of customized output screens.

Navigation within the program was based upon the principles of the Transtheoretical Model of Behavior Change (TTM), which proposes that long-term smoking cessation is a sequential process involving five stages of change: precontemplation, contemplation, preparation, action and maintenance, as determined by the individual’s readiness to quit (Prochaska and DiClemente, 1983; Prochaska et al., 1991). Because the goal of this intervention was to motivate readiness to quit among women who were current smokers, the program navigated through only the first three stages of change. Within each branch, the user received stage-appropriate messages about the health effects of smoking and strategies for quitting that addressed individual smoking motives and concerns.

**Program evaluation**

Formative and summative evaluation strategies were utilized in the usability test design. Experts in smoking cessation and women’s health reviewed program content throughout development. The
design team created a prototype of the program for analysis by health care professionals familiar with intended users. Formative feedback was incorporated into the design of the final program.

A summative evaluation strategy tested usability in a naturalistic environment. Institutional Review Board approval was obtained to recruit participants from women at a neighborhood community health center primarily serving the medically indigent while awaiting their clinic appointments. The computer and touch-screen monitor were contained within a portable cabinet to provide mobility within the clinic. Participants who met inclusion criteria were taken to a private area to complete all study procedures. After giving informed consent and completing paper-and-pencil baseline measures, participants were instructed on how to launch the interactive computer program. A trained research assistant observed the participants during use of the program and recorded a summary statement of each use. After finishing the program, participants completed a usability survey. Participants were contacted by telephone after 1 week to assess changes in cognitive measures and selected behavioral indicators of the utility of the program.

Usability of the interactive program was assessed using a 14-item investigator-developed tool measuring satisfaction with usability of the program including ease of using the program (three items), efficiency (one item), comfort with using a computer (three items), and acceptability of a computerized learning format (seven items). In addition, two open-ended questions were included to obtain individual user preferences. Cognitive measures of the utility of the program were assessed using two well-established instruments based on the precepts of the TTM: the Decisional Balance Scale (Velicer et al., 1985) and the Processes of Change–Short Form (POC-SF) (Prochaska et al., 1988). See Table I for information on the study scales.

Data analysis plan
Descriptive statistics were used to examine demographic and smoking variables. Relationships among participant characteristics and satisfaction with program usability were examined using t-tests and one-way analysis of variance. Repeated measures analysis of variance was used to detect changes in cognitive factors associated with smoking from baseline to follow-up. A $\chi^2$ analysis was used to detect change in participants’ stage of change for quitting.

Results
Sample
A non-probability sample of 110 women smokers was recruited from 228 eligible women approached in the clinic. Time constraint was the most frequently cited reason for refusal to participate. The final sample consisted of 100 women (91% of those enrolled) between the ages of 18 and 71, with a mean age of 41.5 years (SD = 12.4). Two subjects left the clinic before completing the computer program and eight were lost to follow-up. The majority (68%) of the participants were Caucasian. Educational level was typical of an inner-city population, with 35 participants reporting that they did not complete high school. Participants reported a long history of smoking ($M = 22.8$ years, SD = 12.5) with a mean age of smoking onset at 16.7 years (range 9–36 years).

Usability
Observational data
Initially, we observed several problems with the navigation and interface of the interactive program. Occasionally, some content inappropriate to the user was being delivered onscreen. The program was modified by re-specification of the control algorithms to ensure appropriate messages were delivered to the remaining 85 users; however, the data from the first 15 participants were retained in order to minimize bias of the results.

Average time required to complete the program was 13.9 minutes (range 7.2–88.8 minutes). Field notes revealed that the outlier (88.8 minutes) occurred due to interruptions while the participant completed the program. No one failed to complete
the program; only one subject requested assistance with using the touch-screen monitor.

Usability survey results
Participant rating of satisfaction with usability of the program was high. The mean score on this measure was 60.2 (SD = 6.3) with a possible range of 14–70 (actual range 40–70). There were no relationships between usability scores and age, health status or prior computer experience. Minority participants were significantly more satisfied with usability of the computer program than Caucasian participants. Satisfaction with usability was significantly higher in women with at least a high school education. Stage of change was significantly related to usability scores, with women who were only thinking about quitting (precontemplation stage) being least satisfied with using the program. See Table II for comparison of significant relationships with satisfaction with usability.

Content analysis of the response to open-ended questions revealed several positive themes: ease of use (n = 52), quality of information (n = 18), use of technology (n = 15) and ‘fun’ (n = 6). Four participants noted that the best feature was the non-threatening approach to smoking cessation. One woman responded that she liked the privacy afforded by the interactive program.

### Table I. Psychometric properties of study measures

<table>
<thead>
<tr>
<th>Instrument</th>
<th>No. items</th>
<th>Response format</th>
<th>Content/concept</th>
<th>Reliabilitya</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usability survey</td>
<td>14</td>
<td>five-point Likert-type free response</td>
<td>satisfaction with program usability</td>
<td>Cronbach’s α = 0.76</td>
</tr>
<tr>
<td>(McDaniel et al., 2002)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decisional Balance Scale</td>
<td>20</td>
<td>five-point Likert-type</td>
<td>decision making about smoking: Pros and Cons subscales</td>
<td>Cronbach’s α Pros = 0.87 (0.84); Cons = 0.90 (0.83)</td>
</tr>
<tr>
<td>(Velicer et al., 1985)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POC–SF</td>
<td>20</td>
<td>five-point Likert-type</td>
<td>cognitive processes associated with quitting smoking: Experiential and Behavioral subscales</td>
<td>Median Cronbach’s α = 0.88 (0.87)</td>
</tr>
<tr>
<td>(Prochaska et al., 1988)</td>
<td></td>
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</tbody>
</table>

aReliability in parentheses indicate this study

Table II. Sample characteristics and relationship to satisfaction with program usability (N = 100)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean (SD)a</th>
<th>Test statistic</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnicity</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian (n = 68)</td>
<td>59.1 (5.92)</td>
<td>t = 2.156</td>
<td>0.034</td>
</tr>
<tr>
<td>minority (n = 32)</td>
<td>62.0 (6.68)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Educational level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>did not complete high school</td>
<td>57.7 (6.08)</td>
<td>F = 4.332</td>
<td>0.016</td>
</tr>
<tr>
<td>(n = 35)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>high school graduate (n = 38)</td>
<td>61.0 (6.47)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>attended college (n = 27)</td>
<td>61.8 (5.49)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage of change</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>precontemplation (n = 19)</td>
<td>55.7 (5.47)</td>
<td>F = 10.15</td>
<td>&lt;0.00</td>
</tr>
<tr>
<td>contemplation (n = 68)</td>
<td>60.4 (6.14)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>preparation (n = 13)</td>
<td>64.9 (3.73)</td>
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</tbody>
</table>

aRange of scores across entire sample was 40–70.

Changes in cognitive measures
After using the program, participants reported a significant decrease in favorable attitudes toward smoking, as measured by the Pros of Smoking subscale of the Decisional Balance Scale, regardless of stage of change (RMANOVA, F = 6.31, P = 0.014). There was no significant difference in negative perceptions of smoking (i.e. ‘Cons’ subscale). There was a significant increase in scores on
the Experiential subscale of the POC-SF (e.g. substituting another behavior when tempted to smoke, consciously avoiding smoking 'triggers') at follow-up (RMANOVA, $F = 4.47$, $P = 0.037$) across the three stages of change. Overall, 15% of participants progressed at least one stage of change after completing the program ($\chi^2 = 88.8$, d.f. = 6, $P < 0.001$).

**Discussion**

The purpose of this study was to design and test the usability of an interactive computer-mediated smoking cessation intervention for inner-city women. Incorporating user beliefs into content delivery is critical to the design of an effective interactive patient education software program. The findings of this study suggest that information technology has potential for delivering brief smoking cessation intervention for low-income women in primary care.

The application of focus group findings as a user-centered design strategy resulted in important information for targeting content and delivery of tailored smoking cessation messages. For example, findings from the focus group indicated that preference for source of information was dependent upon message content. Results of the usability survey and open-ended feedback suggest that incorporating this information into the program was successful. Eliciting user input in designing interactive consumer health products is essential to maximize impact and acceptability.

Users found the program easy to use via the touch-screen interface. Although a research assistant was available to assist participants in using the program, only one of the users required assistance with the touch-screen input process. Participants were highly satisfied with the application as indicated by the usability survey results. Although most usability studies employ strictly direct observational methods with a small purposive sample in a laboratory setting, this study examined evidence from multiple sources to support usability. We evaluated time to complete the program, field notes and reported satisfaction with a relatively large sample of end-users in a naturalistic environment, i.e. patients within the clinic setting. We believe this methodology is critical for testing usability in the target population of low-income women, who have less experience with interactive technology.

Another important factor in usability is the utility of the program for achieving intended goals. In this case, the purpose of the interactive program was to motivate cognitive and behavior change in smoking behaviors. Assessment of the short-term cognitive and behavioral indicators of change demonstrated progress in cognitive processes of change and decisional balance after use of the interactive computer program. Participants reported engaging in more behavior-oriented strategies, such as seeking help from others, removing smoking cues from the environment or avoiding tempting situations. The findings suggest that this method may be effective for presenting motivational content.

The results of this study must be interpreted with caution due to the limitations of the study design, particularly the lack of a control group. Without a control group, the impact of the interactive program cannot be evaluated. In addition, long-term effects of the program cannot be determined because the follow-up period was brief (1 week). The relatively high refusal rate also dictates cautious interpretation of the findings. It is likely that women who were less motivated to quit smoking had higher rates of refusal, resulting in a biased sample. Nevertheless, this study supports the use of interactive computer technology as a feasible method for motivating smoking cessation in low-income women. Based on our findings, future studies employing randomized controlled trial methods are needed to determine both efficacy and long-term effects of the intervention on smoking cessation.

**Implications for practitioners**

The women in this study reported a high level of satisfaction with usability of the program despite relatively little experience using computers. Usability testing is an important dimension of evaluation
for such technologically based health interventions. Usability testing incorporating evidence from multiple sources may enable practitioners to have greater confidence in the efficacy of such interventions in the clinical arena.

Low-income women, such as the participants in this study, have high rates of smoking and limited access to resources to assist with cessation. An important implication of this study is that a theoretically derived, interactive program can provide brief smoking cessation intervention in the primary care setting with minimal burden to users. The results of this study indicate that computer technology can be used to deliver tailored information intended to change health behaviors in underserved populations.

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References


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