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The effectiveness of an interactive multimedia program to influence eating habits

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Abstract

An interactive multimedia program to encourage individuals to decrease their dietary fat consumption and to increase consumption of fruits and vegetables was developed and evaluated at two worksites. The program presented content tailored to the user by gender, content interests, race, and age group. It was tested using a randomized treatment and wait list control design (n = 517). Repeated-measures ANOVAs indicated significant intervention effects after 30 days for self-reported consumption of fat and of fruits and vegetables, for stage of change to adopt a low-fat diet, for intention and self-efficacy to reduce dietary fat, and for attitude toward the importance of diet. In addition, 60-day follow-up of the treatment subjects found that program effects were maintained on all measures. Within-subject analyses showed that program effects were replicated with the wait list group at 30 days. These results demonstrate the potential for short-exposure interactive programs to positively impact eating habits of employee populations.

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Introduction

Poor eating habits may lead to increased risk of chronic disease (US Department of Health and Human Services, 1988; National Research Council, 1989; World Cancer Research Fund and American Institute for Cancer Research, 1997). Specifically, individuals who consume too much dietary fat, too little fiber, and not enough fruit and vegetables are at risk of heart disease, stroke, diabetes and cancer (Bal and Foerster, 1991; US Department of Health and Human Services, 1991). Scientists recommend that the US population decrease fat consumption to 30% of total caloric intake, increase intake of dietary fiber, and increase fruit and vegetable consumption (US Department of Agriculture and US Department of Health and Human Services, 1995). Making the behavioral changes necessary to change eating habits is not easily accomplished. However, even small percentile changes in eating behavior, if they are derived at the population level, can have an important effect on public health and impact millions of people. Theoretically driven interventions that focus on behavior change and factors influencing food choice are needed (US Preventive Services Task Force, 1996; Glanz *et al*., 1998; Brug *et al*., 1999a; Glanz, 1999).

A number of research interventions have tried to decrease consumption of dietary fat. Programs have been conducted in schools, in communities, at worksites, and at Health Maintenance Organizations (see review by Glanz, 1999). Worksites are an especially promising venue for dietary change programs because employees return repeatedly to the same site and on-going worksite

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health promotion programs are often already in place [e.g. (Pelletier, 1993, 1996)]. The efficacy of worksite programs, however, is still in doubt because of a lack of rigorous research (Harden *et al*., 1999). The most effective worksite dietary intervention strategies have used theoretically based intervention strategies (Glanz, 1999), including Stage of Change (Prochaska and DiClemente, 1983, 1984) as adapted for dietary interventions [e.g. (Curry *et al*. 1992; Glanz *et al*., 1994; Kristal *et al*., 1999)], the Theory of Reasoned Action (Fishbein and Ajzen, 1975; Ajzen and Fishbein, 1979, 1980) and Social Cognitive Theory (Bandura, 1977, 1986). Research suggests that multifaceted dietary change programs are most effective, apparently because different program components appeal to the diverse needs and issues of the groups being studied [e.g. (Glanz, 1999; Kristal *et al*., 2000)]. Components shown to be effective include presentations, audiovisual materials, counseling, dietary assessment and behavioral feedback, self-help manuals and tailored written materials, mailings, and telephone counseling and support (Glanz, 1999; Kristal *et al*., 2000). The most efficacious components or combinations of components, however, have yet to be identified.

A key part of the success of multicomponent dietary interventions appears to be the ability to individualize a generalized intervention approach in multiple ways for different individuals [e.g. (Campbell *et al*., 1994; Brug *et al*., 1999a,b)]. Kreuter and Skinner (Kreuter and Skinner, 2000) suggest the term 'tailoring' be used to describe messages designed for individuals and 'targeting' be used to describe messages destined for groups (e.g. gender, race/ethnicity). Tailored print communication (TPC) has been shown to be effective [see reviews by (Brug *et al*., 1999a; Skinner *et al*., 1999)]. For TPC, computers are used to sort available information and produce mailings tailored to specified criteria such as an individual's gender, risk factors, motivations or stage of change. Multiple studies show TPCs are more likely to be noticed and read than non-tailored print messages (Campbell *et al*., 1994, 1998; Strecher *et al*., 1994; Brug *et al*., 1996, 1999a,b). TPCs are also more likely to influence health behavior change than non-tailored print messages (Brinberg and Axelson, 1990; Campbell *et al*., 1994; Skinner *et al*., 1994; Brug *et al*., 1996, 1998, 1999a). TPCs demonstrate the promise of using computer tailoring to change health behaviors and this potential may well increase as technology improves (Kreuter *et al*., 2000).

The trend toward multicomponent dietary intervention research in some ways reflects how programs would be developed in an individualized treatment intervention. Based on a client's needs, a trained dietician would recommend a personalized program to change eating habits. Ideally, the recommendations would target the client's motivation and interests, and use behaviorally based approaches (e.g. stage of change, behavioral intention, self-efficacy). While such individualized treatment often is not cost-effective, the same computer technology that allows component sorting and delivery of TPCs can be used to mimic one-on-one-counseling (Noell and Glasgow, 1999; Kreuter *et al*., 2000). Interactive systems (e.g. Internet or intranet) that provide individualized treatment are a potentially attractive option because this approach can be used in situations in which professional counselors are not available or affordable. A small non-randomized study using a CD-ROM that provided text-based nutritional screening and counseling showed the promise of this approach (Block *et al*., 2000).

Interactive multimedia (IMM) programming, which combines audio, video, graphics and printout, is appealing as a substitute for an individualized counseling program for several reasons in addition to its cost-effectiveness. IMM can create the sense of a personalized television program. The targeting and tailoring capabilities of the computer allow the program to assess user characteristics and interests, and make user-specific recommendations. An IMM video counselor and motivational elements can be demographically matched to the user (e.g. by age, race and gender). If the program is skillfully developed, it can use behaviorally based strategies to improve attitudes, boost self-

efficacy, and create the intention and commitment to make changes. An IMM approach should be particularly effective for individuals with poor reading skills, a group not well suited for TPC interventions. For users with adequate reading skills, a tailored summary printout can reinforce program messages and remind the user of commitments made in the program. An IMM intervention also provides quality control: the intervention is presented exactly as designed every time.

An IMM approach is not without some potential risks. Video programs are expensive to develop and are not easily updated if they become outdated. Interventions may sometimes be more appropriately delivered by an experienced professional. For instance, complex topics may require qualitative assessment and treatment, or the intervention target may be afraid of computers or may benefit from interpersonal contact because of language difficulties or for other reasons. Finally, an interactive intervention program is potentially vulnerable if the user does not attend to the program elements that most effectively promote the program's objectives.

While research into the impact of IMM programs is still in its infancy, Campbell *et al.* (Campbell *et al.*, 1999) suggest that tailored IMM programs may effectively reach under-served populations and that audiovisual elements are more effective than print for those with limited literacy skills. We were unable to find other research testing the impact of IMM interventions on dietary behaviors.

Our research looked at the impact of an IMM program designed to help individuals decrease their consumption of fat. Several research questions were examined:

- Did exposure to the program lead to changes in variables theoretically associated with behavior change, including stage of change, attitude, self-efficacy and intention to change?
- Were changes maintained a month after initial exposure?
- Were these results replicable with another sample of study participants?

Methods

Program development

For this research we developed an IMM worksite intervention program to help employees decrease their fat consumption. Our underlying assumption was that participants would choose to view parts of the IMM program that were of personal interest and ignore topics that were perceived to be unappealing or of little interest. Program material was shaped by several theoretical constructs discussed below.

Stage of change

Following the Transtheoretical Model of Prochaska and DiClemente (Prochaska and DiClemente, 1983), which has been tested on a number of health behaviors (Prochaska and Velicer, 1997), the Stage of Change construct suggests that readiness to make dietary changes may be assessed along a continuum (Kristal *et al.*, 1999): *precontemplation* (no plans to change), *contemplation* (indeterminate plans to change, no change attempts), *preparation* (plan to change, have made attempts), *action* (having eaten a low-fat diet for less than 6 months) and *maintenance* (have eaten a low-fat diet for 6 months or longer). We assumed an individual would not choose program options for which s/he was a precontemplator. Program elements were written to encourage users in the contemplation and preparation stages to make an attempt to change (progress to the action stage), and to do so in small steps to encourage success and long-term adoption. Testimonial support to overcome barriers to changing behaviors was included. We expected individuals in the action or maintenance stage to find content to support their current behaviors and to seek out topics in areas where they were still in the contemplation or preparation stage. Opportunities to commit to specific new behaviors (move from preparation to action) were offered by asking users to identify up to four recommended behaviors to do in the next 2 weeks. When users identified recommended behaviors in which they were

already engaged, the program provided support (action and maintenance stages).

Attitudes

Attitudes about eating habits for self and family were targeted with testimonials and modeling vignettes to normalize perceptions of healthy eating behavior. The importance and health benefits of eating less dietary fat were stressed.

Intentions

The Theory of Reasoned Action posits that attitudes and behavioral intentions predict behavior (Ajzen and Fishbein, 1979, 1980). Video testimonials offered encouragement to try recommended behaviors. Commitments to try new behaviors were supported and they were prominently displayed on each user's tailored printout.

Self-efficacy

The concept of self-efficacy involves the personal conviction that one can successfully execute the behavior required to produce a desired outcome. A change in one's belief about his/her ability to successfully execute a given behavior will mediate the initiation and maintenance of change in that behavior (Bandura, 1977, 1986). Social Cognitive Theory (Bandura, 1977, 1986) and Health Communication Theory (Witte, 1995) suggest that messages from perceived peers will resonate more strongly with the user who hears and sees the message. Our IMM program delivered positive self-efficacy messages via video modeling vignettes, supportive testimonials and testimonials about overcoming barriers to changing behaviors. Actors were demographically matched to each viewer to promote message salience.

Summary

Our IMM program was designed to combine theoretical approaches. Positive attitudes and self-efficacy were promoted by peer models to encourage intention to advance to the action stage of change. Support was provided for those in the action and maintenance stages. Intention to change was promoted with encouragement to make commitments to specific behaviors, which were supported on tailored printouts. Barriers to change were addressed with supportive testimonials designed to build self-efficacy. Throughout the program, video narrators targeted to the user's demographics offered guidance and support, while modeling videos and testimonials encouraged positive behavioral change and boosted self-efficacy.

Subject recruitment

This research was conducted at a large hospital system in Colorado and at the headquarters of an international corporation in Illinois. The Colorado site (n = 229 subjects) consisted of a main 500 bed hospital, two associated hospitals, and additional ancillary clinics and facilities (n = 4000 employees). Recruitment targeted the main hospital, but volunteers were accepted from other facilities. The Illinois site (n = 288 subjects) employed about 1200 employees in a single building, but was in the midst of downsizing to about 1000 employees. At both sites, participant recruiting occurred over a 3-month period. Because we anticipated that less-educated employees would be more difficult to enroll in a project that required filling out questionnaires, the first 3 weeks focused on recruiting low-wage workers (e.g. clerical staff, food workers). Announcements were made at staff meetings, and flyers were posted and distributed by our liaisons at each worksite. When recruiting was opened to the general employee population, additional recruiting strategies employed newsletter articles, E-mail messages, staffed tables at Health Fairs and word of mouth. In Illinois, a letter from the corporate Medical Director to all employees that promoted the program appeared to be linked to an increase from 68 to 148 recruits in a 2-week period, but no other single technique was obviously as effective. Any employee who volunteered was invited to participate in the study,

Research design

The study was a randomized trial with a wait list control (Figure 1). Volunteers at each site were mailed a packet containing an informed consent form, a questionnaire (T1), a stamped return mailer

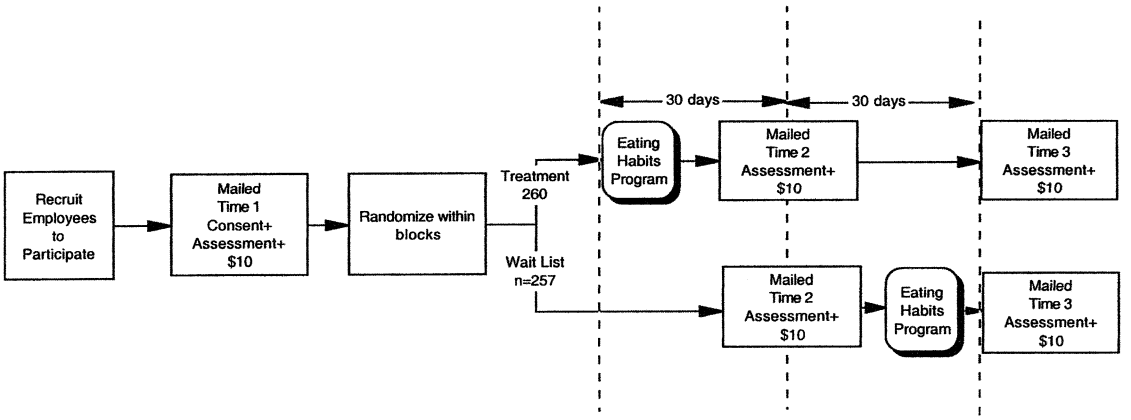

Fig. 1. Evaluation design: randomized experiment.

and a $10 cash incentive. The recipients were asked to sign the informed consent, fill out the T1 questionnaire and return both items in the mailer. They were informed that the money was theirs to keep. When the return packets were received, the employees were blocked based on gender, age (over 40 versus under 40 years of age), ethnic/racial self-identification (African-American, Hispanic and Caucasian/other) and worksite. Subjects were paired within these blocks and then randomly assigned to either an immediate treatment (IT) or a wait list (WL) condition. IT subjects were scheduled to use the program; WL subjects were told they would receive access in 1 month. One month after the IT member of each randomized pair viewed the IMM program, both pair members were mailed a follow-up questionnaire (T2) with a stamped return mailer and another $10 cash incentive. Following the return of the T2 questionnaire, subjects in the WL group were scheduled to use the program. Neither IT nor WL group participants were given financial incentives for using the program. One month after the T2 assessments were mailed, the IT group was mailed a third packet containing another assessment (T3), a stamped return mailer, and another $10 bill. This T3 questionnaire for the IT subjects provided a 2-month follow-up after initial use of the program. One month after each WL group member used the program, s/he was mailed an identical T3 packet.

IMM program use procedures

The IMM intervention software ran on an inexpensive personal computer (200 MHz; 64 Mb RAM; sound card). Three computers, a server and a printer were shipped to each site, and remained available for repeated use by participants during the course of the study. The computer stations were situated to protect the privacy of the user from over-the-shoulder observers and each was equipped with earphones. In Colorado, the computers were located in a temporary cubicle in the main hospital's cafeteria; in Illinois, they were located in adjoining cubicles next to the company store.

Users interacted with the program using a mouse to click on buttons on the screen. No keyboarding skills were needed. Most of the on-screen graphics were narrated to assist poor readers. Narration and testimonial scripts (see below) were analyzed by Microsoft Word and had a Flesch–Kincade grade level of 5.3. On screen text had a 1.5 grade level, while articles in the *Information Center* were written at a Grade 8 reading level.

Because repeat visits to use the IMM computer program were encouraged, each user was initially prompted to develop a password to protect his/her

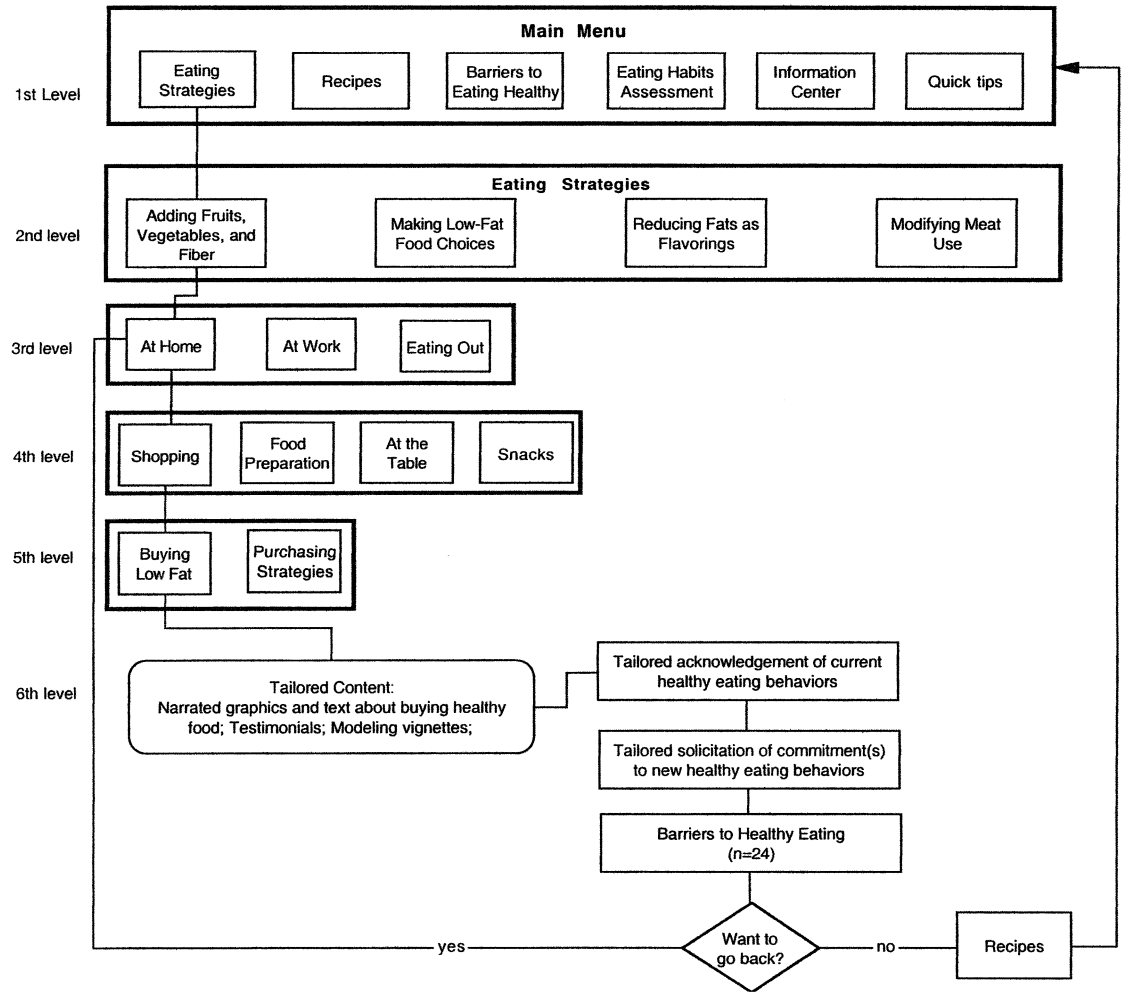

Fig. 2. Schematic of one pathway from the *Eating Strategies* menu through the *Adding Fruits, Vegetables, and Fiber* eating strategy (see text for details).

privacy. The password permitted the computer to access a user's previous data entries as needed (e.g. to compare assessment results across visits). A welcome by the program host, television personality and internationally recognized chef Graham Kerr, followed the login/password sequence. The user then answered a series of mandatory questions that allowed the program to provide a narrator/guide matched on race and gender. The narrator encouraged the user to allow him/her to be a guide through the program. Users who opted to not be guided through the program were routed to the *Main Menu* and allowed to explore from there.

For those who agreed to a guided tour, the narrator offered an on-screen eating habits assessment adapted from the work of Glanz, Kristal and colleagues [e.g. (Glanz *et al*., 1994, 1998; Kristal *et al*., 2000)]. Based on this assessment, the program took the user to the *Eating Strategies* section (see Figure 2), which recommended a low-

fat dietary strategy appropriate for that user. Because the program was interactive, each user had the option of exploring different parts of the recommended strategy or moving elsewhere in the program. At any time, users could change pathways within a strategy or go to the *Main Menu* to explore other program components.

Program navigation was designed to be intuitive for the user, but in reality the program is quite complex. Because content is tailored by user demographic characteristics, program recommendations and user choices, there are literally millions of unique combinations of program elements available to each user (see Figure 2).

As an overview, the program sections accessible from the first level *Main Menu* included: *Eating Strategies*, *Recipes*, *Barriers to Eating Healthy*, *Eating Habits Assessment*, *Information Center* and *Quick Tips*. The *Recipes*, *Barriers to Eating Healthy* and *Eating Habits Assessment* sections could also be accessed through the Eating Strategies section, as described below.

The *Eating Strategies* (see Figure 2, second level) were based on established recommendations to decrease dietary fat [e.g. (Bal and Foerster, 1991; US Department of Health and Human Services, 1991)]: *(1) Reducing Fats as Flavorings*, *(2) Making Low-Fat Food Choices*, *(3) Adding Fruits*, *Vegetables and Fiber*, and *(4) Modifying Meat Use*. Each strategy had multiple subpathways. For instance, as shown in Figure 2, the *Adding Fruits, Vegetables, and Fiber* pathway included three third-level choices: *At Home*, *At Work* and *Dining Out*. If the user selected *At Home*, the fourth-level set of choices were *Shopping*, *Food Preparation*, *At the Table* and *Snacking*. Had the user selected a different third-level choice, the interactive options in the fourth level would have differed also. If the user selected *Shopping*, two pathways, *Buying Food* and *Reading Labels*, were available at the fifth level. The sixth level provided educational information relevant to the chosen topic from the fifth level.

On-screen text was delivered in short bulleted statements, usually explained by the demographically tailored narrator, followed by a modeling video and then two to three tailored video testimonials designed to motivate acceptance of the just-presented strategy recommendations. Text recommendations were small practical steps (e.g. 'add fruit and veggies when you pack your lunch'), while video elements modeled simple changes (e.g. a short personal testimonial with the statement 'so, I started ordering salad dressing *on the side*').

In each content area, the user was asked to identify which recommended behaviors s/he was already doing and to commit to the behaviors that s/he was willing to try in the next week. Following this, the user was asked to identify potential barriers to fulfilling the commitments just made from a total of 24 potential barriers (e.g. *dealing with temptations and cravings*; *don't have enough time*). For chosen barriers, video models delivered short testimonials describing how they overcame the selected barrier. From the *Barriers* pathway, the user was routed back to the previous *Eating Strategies* pathway. Users could browse the *Eating Strategies* section until they made a total of six commitments. Then they saw a review and support for making commitments to change followed by a testimonial from the program host. Next, users were routed to a menu with an audio recommendation to visit the *Recipe* section and then to the *Main Menu* to browse the program at will.

Program video elements consisted of (1) more than 700 short testimonials providing tips, advice and encouragement, (2) 24 vignettes modeling recommended eating behaviors (e.g. the fork-dip method, ordering low-fat menu items), (3) about 240 min of short video segments of six narrators (matching users on gender and race) providing guidance and support, and (4) approximately 60 min total of voice-over narration explaining individual content screens. The video testimonials and modeling vignettes ranged from 20 to 45 s long. Video segments of narrators ranged from 5 to 60 s. Voice-over audio clips accompanying content screens were 5–40 s in length. The modeling vignettes were enacted by a multicultural cast. Video testimonials were usually presented as a sequence of two to three related video clips. In the first video clip of a sequence, the actor was *fully*

matched to the three demographic parameters of the user (i.e. gender, race and age). The actor in the second testimonial was matched on at least two of the three. If a third testimonial was presented, it was matched on at least one of the three.

The *Recipe* section of the program contained over 1500 low-fat recipes, which could be printed out. The recipes were developed by Graham Kerr and by Micro Cookbook, 5.0 (IMSI Software, Novato, CA). Recipe selection was facilitated with four pop-up selection criteria: recipe category (30 categories), meal type (12), main ingredient (20) and cuisine type (12). For example, a user might specify the recipe category as casserole, meal type as main dish, main ingredient as chicken and cuisine type as Italian. The recipes meeting the criteria would then be displayed and could be printed. The *Information Center* had six second-level choices that branched into three or four more levels providing educational articles, dietary information and resource referral to national organizations. The *Quick Tips* section contained five second-level choices that branched to short content lists in the third or fourth levels.

Upon leaving the program, each user automatically received a printout. It included a list of the user's four behavior change commitments, summaries of program selected content from eating strategy pathways, and user-selected content screens and recipes.

Measures

With the exception of six demographic questions on the T1 questionnaire, each participant completed the same questionnaire at T1, T2, and T3. It consisted of 42 items, with 23 of the items first asking if a specific behavior or attitude was relevant and, if so, a Likert scale subpart followed. Pilot testing indicated that the questionnaire could be completed in 10–15 min.

Fat eating habits/behaviors

The 21-item diet habits questionnaire (DHQ) was adapted from an instrument designed to assess food preparation patterns associated with adoption of a low-fat diet (Kristal *et al*., 1990). It has been modified to measure dietary change in the previous month (Kristal *et al*., 1992, 2000; Glasgow *et al*., 1996; Shannon *et al*., 1997; Neuhouser *et al*., 1999). The DHQ assesses five dimensions of low-fat dietary habits including substitute, modify meats, avoid fried foods, avoid fats as flavorings, and replace fatty foods with fruits and vegetables. Twenty of the items ask about the relevance of a behavior (e.g. 'Did you eat snacks between meals?', 'Did you use mayonnaise?'). If the response is positive, a subpart asked about the frequency with which the behavior was part of a low-fat strategy (e.g. snacks: 'How often did you eat low-fat snacks or fresh fruit?'; mayonnaise: 'How often did you use a low-fat or non-fat type?'). Frequency is rated on a four-point scale: usually or always, often, sometimes and rarely or never. The last item of the 21-item scale asks participants to rate how often they eat two or more vegetables at dinner or their main meal using the same four-point frequency scale. The DHQ summary scale is the mean score on the four-point scale across the 21 behavioral items. The psychometric properties of this scale differ only modestly across studies [e.g. (Kristal *et al*., 1990, 2000; Shannon *et al*., 1997)]. The internal consistency (Cronbach's α) of the summary scale ranges from 0.63 to 0.67. Test–re-test reliability for the summary score is consistently above 0.70. Correlations of the DHQ summary scale with percent energy from fat measured by a food-frequency questionnaire range from 0.53 to 0.68. Confirmatory factor analysis of the pre-test data in the current study yielded a solid comparative fit index for the five dimensions of the DHQ equal to 0.91, χ^2 (156, N = 417) = 234.47, $P < 0.001$.

Fruit and vegetable consumption

Fruit and vegetable intake was assessed with the same approach used in the '5-a-day for better health' studies (Subar *et al*., 1995). The items ask about the frequency of consumption of fruit juice, fruit, green salad, non-fried potatoes, and servings of vegetables not including potatoes and salad. The frequency choices were 9- or 10-point scales ranging from none/never to five servings per day.

Fruit intake was the sum of 'fruit juice' and 'fruit, not counting juice'. Vegetable intake is calculated as the sum of non-fried potatoes, salads and vegetables not including salad and potatoes. This approach of summing the foods consumed has moderate validity compared to multiple 24-hour dietary recalls and food records, although it underestimates total vegetable consumption, probably due to not counting vegetables consumed in mixed dishes (Kristal *et al.*, 1998).

Program recommended behaviors (program specific)

A total of seven items were developed to measure the impact of program recommendations on specific healthy eating behaviors. Each item began 'In the past month, how often have you…?', followed by one of seven topics: 'tried to pick healthier food while grocery shopping?, 'tried to pick low-fat foods while grocery shopping?', 'chosen a new food because you had heard it was healthy?', 'tried to use less fat when preparing a meal (e.g. broiling instead of frying, baking with low-fat recipes)?', 'tried to eat less fat at home (e.g. using less salad dressing, using less or no butter on bread)?', 'ordered healthier food when eating out?', 'tried to eat less fat when eating out?'. Responses to each item were on a 6-point Likert scale with responses ranging from never to frequently. Principal components factor analysis yielded a single-component solution accounting for 60.5% of the variance in these items. This single factor score, called Program Recommended Behaviors, represented this set of healthy diet behaviors in our analysis. In the current study the pre-test Cronbach's α was $r = 0.89$.

Stage of change

The five-item stage of change instrument to assess adoption of a low-fat diet developed by Kristal and colleagues (Kristal *et al.*, 1999) was used for this study. It was validated in the Working Well Trial (Glanz *et al.*, 1998). One month test–re-test reliability (T1 to T2) among our WL subjects was $r = 0.69$.

Attitudes

Two attitudinal items previously developed by Kristal *et al.* were used to predict dietary change (Patterson *et al.*, 1995, 1996). One item measured the respondent's reaction to a statement about the importance of what is eaten to health on a five-point scale (strongly agree, agree, don't know, disagree and strongly disagree). The other item asked whether what one eats is related to heart disease, with three responses possible (don't know, no, and yes). Those responding 'yes' were asked to rate the strength of the relationship on a four-point scale (strong, moderate, weak and don't know). One month test–re-test reliabilities (T1 to T2) among WL subjects were $r = 0.39$.

Behavioral intention

To assess the constructs of the theory of reasoned action (Fishbein and Ajzen, 1975; Ajzen and Fishbein, 1980), a single questionnaire item was developed to assess participant intention to lower the fat in their diet in the next month, using a four-point Likert Scale with responses of not likely, somewhat likely, quite likely and extremely likely. One month test–re-test reliability (T1 to T2) among our WL subjects was $r = 0.52$.

Behavioral self-efficacy

Following social cognitive theory (Bandura, 1977, 1986), participants' self-efficacy to decrease dietary fat intake was assessed with a single item which asked 'If you wanted to lower the fat in your diet, how confident are you that you could do it?'. This rating was on a 5-point scale of very confident, somewhat confident, not confident and don't know. One month test–re-test reliability (T1 to T2) among WL subjects was $r = 0.61$.

Results

Subjects

Table I provides descriptive information about the sample of 517 participating employees. They averaged 43 years of age, and were predominately Caucasian (85%) and female (73%). Almost 90%

Table I. *Demographic information for participating employees*

Variable	All cases (n = 517)		Treatment (n = 260)		Wait list (n = 257)	
	M	SD	*M*	SD	*M*	SD
Age	42.78	(10.41)	42.48	(11.15)	43.08	(9.62)
Gender (%)						
female	72.7		73.1		72.4	
male	27.3		26.9		27.6	
Race (%)						
Caucasian	85.4		88.8		81.9	
African-American/black	5.1		5.0		5.1	
Hispanic/Latino	4.7		2.7		6.7	
Native American	1.2		0.8		1.6	
Asian/Pacific Islander	3.1		2.7		3.5	
other	0.6		0.0		1.2	
Income (%)						
<$20000	3.5		4.2		2.9	
$20000–$39999	21.1		22.9		19.3	
$40000–$59999	20.5		20.4		20.6	
$60000–$80000	24.0		22.5		25.5	
>$80000	30.8		30.0		31.7	
Education (%)						
some high school	0.6		0.4		0.8	
high school graduate	9.9		9.2		10.5	
some college	24.2		23.5		24.9	
college graduate	31.3		32.7		30.0	
graduate/professional degree	34.0		34.2		33.9	
Employment status (%)						
full-time	86.2		83.7		88.7	
part-time	8.5		9.3		7.8	
not employed	1.7		2.3		1.2	
other	3.5		4.7		2.3	

of the participants had some college education and only 3.5% of them had family incomes below $20 000 per year. Eighty-six percent of the participants were full-time employees. There were no significant differences between the worksites by gender, race/ethnicity or age. Attrition from the study was low. Of the 517 individuals who completed T1 surveys, 484 (94%) completed T2 assessment, and 463 (90%) completed the T3 assessment.

Program use

The average time IT subjects spent using the program on their first visit was 35.75 min (SD = 15.75). The WL group at their first session used the program for an average of 32.09 min (SD = 15.70). None of the WL subjects used the program early (before their T2 assessment). Only 14.7% of the IT group (average use time: 27.5 min; SD = 25.0) and 12.07% of the WL group (average use time: 20.2 min; SD = 13.0) returned to use the program a second time. Only 7.5% of the IT subjects and 1.7% of the WL subjects returned for a third time (average use time: 28.6 min; SD = 27.5 and 17.3 min; SD = 15.9, respectively).

Data on the number of recipes printed, a possible indicator of intent to use low-fat recipes, were collected at the initial visit for the WL group. Among the WL subjects, 133 (57.33%) chose to have recipes printed with an average of 12.22 (SD

Table II. *Means and SD for the major outcome measures by condition*; *analysis of variance for comparison of treatment to wait list subjects at 1-month follow-up (condition by time interaction)*; *and* t-*test of maintenance of program effects at 2-month follow-up for treatment subjects only*

	T1 (pre-test)		T2 (1 month)		T3 (2 months)		One-month follow-up (treatment versus control) T1–T2 ANOVA (Condition × Time)			Maintenance effects: 2-month follow-up T1–T3; paired *t*-test (treatment Ss only)		
	M	SD	*M*	SD	*M*	SD	*F*	*P*<	d.f.	*t*	*P*<	d.f.
Fat eating habits/behaviors (DHQ)							28.29	0.001	476	8.44	0.001	228
treatment	2.51	0.45	2.31	0.39	2.27	0.47						
wait list	2.54	0.40	2.50	0.38	2.35	0.41						
Fruits and vegetables consumption							15.79	0.001	475	6.49	0.001	227
treatment	3.00	0.93	3.33	0.88	3.36	0.93						
wait list	3.08	0.92	3.14	0.93	3.32	0.88						
Program recommended behaviors (program specific)							18.46	0.001	432	7.07	0.001	206
treatment	4.44	0.77	4.70	0.67	4.81	0.67						
wait list	4.40	0.73	4.42	0.72	4.69	0.68						
Stage of change							18.57	0.001	473	7.57	0.001	227
treatment	2.50	1.25	2.03	0.98	1.95	0.99						
wait list	2.55	1.22	2.46	1.21	2.05	1.03						
Attitude importance							5.97	0.015	466	4.71	0.001	222
treatment	1.58	0.57	1.45	0.56	1.38	0.52						
wait list	1.55	0.56	1.56	0.55	1.34	0.49						
Intent to decrease fat							10.04	0.002	476	5.34	0.001	228
treatment	2.65	0.89	2.94	0.85	3.01	0.92						
wait list	2.67	0.82	2.66	0.87	2.85	0.89						
Self-efficacy to decrease fat							4.48	0.035	457	3.87	0.001	221
treatment	1.69	0.60	1.59	0.55	1.54	0.55						
wait list	1.76	0.63	1.77	0.60	1.56	0.56						

At T1 treatment $n = 260$, wait list $n = 257$; at T2 treatment $n = 233$, wait list $n = 251$; at T3 treatment $n = 229$ wait list $n = 234$.

= 33.74) recipes printed. One subject printed 367 recipes, suggesting that it might be appropriate to have a limit. Data on recipes printed at the IT subjects' initial visits are not available. However, IT subjects did print an average of 5.5 recipes at the repeat-visit sessions.

Efficacy of program

Randomized trial

Analysis of variance yielded no significant pre-test differences on any of the demographic variables between the IT and WL subjects. The relationship between experimental condition and each of the outcome measures was examined using repeated-measures analysis of variance (pre-test to post-test). As shown in Table II, the condition by time interaction was significant for every one of the outcome measures, indicating that the IT group showed significantly enhanced scores over that of the WL group at 1-month follow-up on each of the seven measures. In addition, the effect sizes were not statistically trivial. The treatment group improving, on average, about one-third of a standard deviation. Of particular interest was the IT group reduction in self-reported fat consumption (i.e. DHQ), a decrease of nearly 0.5 SD. Similarly, IT subjects reported significant increases in the consumption of fruits and vegetables, and on program-recommended healthy eating behaviors. Lastly, each of the four mediating

Table III. *Means and SD for the major outcome measures by sample, and analysis of variance examining within subject 1-month follow-up effects on major outcome measures for initial sample (i.e. treatment subjects) and replication sample (i.e. wait list subjects)*

	Pre-test>		1-month follow-up		Repeated contrast		d.f.
	M	SD	*M*	SD	*F*	*P*<	
Fat eating habits/behaviors (DHQ)							
initial sample	2.51	0.45	2.31	0.39	78.98	0.001	228
replication sample	2.50	0.38	2.35	0.41	48.98	0.001	233
Fruits and vegetables consumption							
initial sample	3.00	0.93	3.33	0.88	55.96	0.001	227
replication sample	3.14	0.93	3.32	0.88	22.16	0.001	230
Program recommended behaviors (program specific)							
initial sample	4.44	0.77	4.70	0.67	32.43	0.001	199
replication sample	4.42	0.72	4.69	0.68	46.10	0.001	201
Stage of change							
initial sample	2.50	1.25	2.03	0.98	45.61	0.001	227
replication sample	2.46	1.21	2.05	1.03	32.24	.001	230
Attitude importance							
initial sample	1.58	0.57	1.45	0.56	12.15	0.001	222
replication sample	1.56	0.55	1.34	0.49	32.67	0.001	227
Intent to decrease fat							
initial sample	2.65	0.89	2.94	0.85	19.78	0.001	228
replication sample	2.66	0.87	2.85	0.89	11.15	0.001	233
Self-efficacy to decrease fat							
initial sample	1.69	0.60	1.59	0.55	6.70	0.010	218
replication sample	1.77	0.60	1.56	0.56	31.89	0.001	219

At T1 treatment $n = 260$, wait list $n = 257$; at T2 treatment $n = 233$, wait list $n = 251$.

constructs derived from theoretical models of health behavior change (i.e. stage of change, attitude, behavioral intention and self-efficacy) consistently supported the efficacy of the intervention with statistically significant improvement in the IT group. The consistency of program effects across all seven outcome measures is notable.

Maintenance of program effects

To determine if treatment effects were maintained at the 60-day follow-up, within-subject T1–T3 data from the IT group was examined. As shown in Table II, paired *t*-test analyses indicate highly significant effects at 60-day follow-up across every one of the seven outcome measures.

Within-subject replication

The wait list design of the study allowed examination of within-subject program effects with the IT group (T1–T2) and with a later replication sample involving the WL group (T2–T3). The results of the randomized trial above demonstrated significant program effects on the IT subjects and the within-subject analyses presented in Table III indicate that those effects replicated well with the WL sample. For all three behavioral constructs (i.e. fat eating habits/behaviors, fruits and vegetables consumption, and program recommended behaviors) and for all four of the theory-driven mediating constructs, the significant gains of the IT sample were replicated in the WL sample.

Program content viewed

Having determined that the program had significant effects, an analysis of subject exposure to program components was undertaken. This analysis is necessarily limited by the variation in pathways chosen by the program users.

The four eating strategies promoted in the program included: Adding Fruits, Vegetables and Fiber; Making Low-Fat Food Choices; Reducing Fats as Flavorings; and Modifying Meat Use. As shown in Table IV, there was high interest in Adding Fruits, Vegetables and Fiber (42%); solid interest in Making Low-Fat Food Choices (25%); and somewhat lower interest in Reducing Fats as Flavorings (17%) and Modifying Meat Use (15%). The average subject explored 2.2 different content pathways. Table V presents the 10 most visited content pathways of the interactive program within the four strategies. Again, highest interest was in the Adding Fruits, Vegetables and Fiber pathways, with eight of the top 10 pathways occurring in this strategy.

Table IV. *Number and percentage[a] of choices of strategy pathways by all users during their first visit*

Strategy pathway	No. of users that viewed pathway	Percentage of all pathway visits
Fruits, vegetables and fiber	239	42
Making low-fat choices	140	25
Reduce fats as flavorings	98	17
Modify meats	87	15

[a]n = 564 total strategy pathway choices by 470 participants.

At the end of each content path, the user was asked to make up to four specific commitments to changing eating behaviors (e.g. use the fork-dip method, pick low-fat menu items when eating out) and identify perceived barriers to the commitments just made (e.g. *dealing with temptations and cravings*; *don't have enough time*). Table VI presents the 10 most frequently viewed barriers. Program users were most interested in learning about ways to deal with three kinds of temptations (327), three issues related to eating out (228) and two items related to low-fat food tasting bad (163).

Discussion

The results of this study are noteworthy for several reasons. First, statistically significant effects were observed at 1-month follow-up both in the randomized trial comparison and in the within-subjects replication. Second, the results were obtained utilizing a fully-automated computerized intervention at worksites; no personal contact was required. Third, this research found significant intervention effects with minimal user exposure (less than 36 min) to an IMM program. Fourth, such IMM interventions can be disseminated broadly over the Internet or via intranet systems at worksites or via CD-ROM. Such broad

Table V. *Number of times the top 10 content areas within strategy pathways were viewed by all users during their first visit*

No. of times viewed	No. of users	Percentage of all users[a]	Content area
124	89	18.9	fruits, vegetables and fiber—at home: cooking vegetables
104	82	17.4	fruits, vegetables and fiber—at home: purchasing strategies
93	72	15.3	fruits, vegetables and fiber—at work: packing a healthy lunch
63	26	5.5	fruits, vegetables and fiber—at home: buying fruits/veggies
61	53	11.3	fruits, vegetables and fiber—dining out: choose low-fat items
58	40	9.0	fruits, vegetables and fiber—at home: at the table
57	37	7.9	modifying meats—at home: shopping for meats
51	46	9.8	fruits, vegetables and fiber—at work: good snacks
50	33	7.0	substitute and/or replace fats—at home: cooking
50	48	10.2	fruits, vegetables and fiber—at home: healthy snacking

[a]n = 470 total users.

Table VI. *Number of times the top 10 barriers were viewed by all users during their first visit*

No. of times viewed	Barrier type	Specific barrier
140	temptation	temptations—user has cravings
113	other	not enough time to eat/shop/cook low-fat
100	temptation	temptations—snacks at work
99	low fat	low-fat foods taste bad
87	eating out	no control when eating out
87	temptation	temptations—love the taste of fatty foods
79	eating out	eating out—fast foods are not healthy
64	low fat	low fat tastes bad—love the taste of fatty foods
62	eating out	eating out—social events
54	other	not sure can change—eating is a stress outlet

utilization can result in significant public health impact even if intervention effects on individual behavior are clinically modest. Fifth, this project represents a rare attempt to demonstrate the efficacy of a video-based IMM program to change self-reported behavior, which is unusual because much of the interactive health communication research to date has involved tailored print messages [e.g. (Brug *et al*., 1999a; Science Panel on Interactive Communication and Health, 1999; Skinner *et al*., 1999; Kreuter *et al*., 2000)]. Taken together, the findings of the study reported here suggest that a video-based IMM intervention that is targeted and tailored to the user has the potential to be effective in changing eating behaviors in real-world settings.

Limitations

Several limitations of this study should be noted. First, the data are all self-reported measures, not observed behavior. Because there is not a one-to-one correspondence between self-reports of behavior and observed behavior, it is somewhat difficult to precisely ascertain the extent to which statistically significant changes in psycho-social constructs and self-reported behaviors found in this study represent actual changes in eating behaviors. Consequently, additional research that utilizes measures of directly observed behavior would strengthen the findings of this study. Additionally, follow-up intervals of more than 30 days might clarify the duration of program effects. While the results appear to be maintained at the 60-day follow-up for the IT group, this was not verified with a randomized comparison in this study. Future studies with 6- and 12-month follow-ups would be instructive. Because the subjects in this study were predominantly Caucasian females and most were college educated, they were not representative of the US workforce. Future research might seek to determine program effects on other demographic groups and on users with limited reading or language skills. Lastly, this study was not designed to determine the relative efficacy of the intervention components. Because this intervention has millions of possible combinations of video, audio, graphic, and content elements that a viewer might experience, a components analysis may prove somewhat challenging, as it has been in other multicomponent dietary interventions [e.g. (Glanz, 1999; Kristal *et al*., 2000)].

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