Using Computer-Based Assessments to Evaluate Interactive Multimedia Nutrition Education Among Low-Income Predominantly Hispanic Participants

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ABSTRACT

Objective: This research was conducted to measure the effectiveness of interactive multimedia (IMM) with low-income Hispanic persons.

Design: The effectiveness of the program was examined using a quasi-experimental pretest/post-test control group design.

Setting: Subjects were recruited from nutrition, health, and English as a Second Language (ESL) programs in Colorado.

Participants: Thirty-six intervention and 34 control participants formed a convenience sample of low-income and predominantly Hispanic persons.

Intervention: Intervention participants received a 15-minute module about breakfast. Control participants received a non–nutrition-related IMM module.

Main Outcome Measures: Primary variables included knowledge, attitude, and stage of change scores.

Analysis: Paired and independent sample *t* tests, chi-square analysis, and repeated-measures analysis of covariance (ANCOVA) were used.

Results: Intervention participants significantly increased knowledge, attitude, and total scores ($P < .001$) between pretest and post-test and had significantly greater increases than the control group ($P < .001$).

Conclusions: The results support using IMM to disseminate nutrition education to the target population and the feasibility of using computer-based questionnaires to evaluate the effectiveness of IMM nutrition education programs.

Implications: This research provides the basis for the continued development of computer-based assessment tools.

KEY WORDS: interactive multimedia, nutrition education, breakfast, low literacy, Hispanic

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INTRODUCTION

Interactive Multimedia The use of computers to deliver education has grown substantially over the last 2 decades.[1,2] Data from the US Census Bureau revealed that as of August 2000, 41.5% of American homes have personal computers. As computer use across the country continues to increase, it is important to determine their effects on knowledge, attitude, and behavior. The field of nutrition education has begun to use computers over the last 5 years, especially interactive multimedia (IMM).[3-7] Interactive multimedia uses audio, text, video, and/or graphics to facilitate 2-way communication between a user and a computer. In addition, using audio, video, and graphics decreases the literacy requirement of the user compared to text-based computer programs. *La Cocina Saludable*, an IMM program consisting of 6 modules teaching basic nutrition topics aimed at low-income and Hispanic mothers, is an example of an IMM program that uses extensive audio and graphics, thereby minimizing the literacy requirement of the user.[8]

Initial studies have shown that IMM is an effective means for delivering nutrition education.[9-18] However, the outcomes reported from these studies are primarily qualitative. For example, Maine's Original Multimedia System (MOMS)

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is a nutrition education program targeted at low-income women. Within this program, 93% of participants reported positive feelings toward using IMM to learn information. The results also showed improvement in 67% of the survey questions from pretest to post-test. However, further conclusions concerning the effectiveness of the program in increasing knowledge and changing attitude and behavior are difficult to ascertain.

Most IMM programs have been developed for children.[9-11,19-21] Only a few programs target adults; even fewer target Hispanic adults. The *La Cocina Saludable* IMM project has been well received by low-income and Hispanic persons in Colorado.[8] The program is based on a 6-unit curriculum initially designed to be delivered by *abuelas* (Hispanic grandmothers). Research showed that the original curriculum was effective in increasing knowledge, skills, and intended behavior in the participants.[22] Because recruitment and retention of participants and *abuelas* were difficult, IMM was pursued as an alternate method for delivering the content included in the *La Cocina Saludable* program. Research revealed that the first 2 IMM modules were effective in increasing knowledge and attitude and intended behavior scores from pretest to post-test.[8] In both the *abuela* and IMM *La Cocina Saludable* programs, researchers have consistently noted that paper and pencil evaluations have been a challenge with low-income Hispanic populations.[8,22] Computers have been suggested as a possible means for overcoming the literacy barriers since all questions and responses can be presented by audio to the participant, and graphics, especially photographs, can be used to enhance understanding.[23]

"Make a Great Start" is the final module of the *La Cocina Saludable* IMM program. It teaches breakfast concepts and integrates concepts from the other 5 modules in the program, including the Food Guide Pyramid, modifying recipes, food safety, child nutrition, and budgeting and shopping skills. The "Make a Great Start" IMM nutrition education module differs from other IMM programs in 3 primary ways: its content, the use of reliable and valid computer-based evaluation tools, and the use of a control group in the research design.

First, the program covers the importance of breakfast and how to plan a healthful breakfast. The addition of a breakfast component has enabled the program to be used in the US Department of Agriculture's Expanded Food and Nutrition Education Program (EFNEP) and the Food Stamp Nutrition Education Program (FSNEP).

Second, "Make a Great Start" was evaluated using reliable and valid computer-based questionnaires to assess changes in knowledge, attitude, and stage of change. Previous studies examining the effectiveness of IMM have used paper and pencil–based evaluation instruments or a combination of computer and paper and pencil–based instruments.[8,12,13,24] The lack of a consistent evaluation instrument was noted as a limitation in one study.[12]

Finally, the "Make a Great Start" module was evaluated using a control group. Again, the use of a control group has been limited in the evaluation of IMM nutrition education programs. The use of a control group in this study allowed the researchers to more effectively determine the benefits of the module on participants' knowledge, attitude, and stage of change while controlling for secular changes.

Theoretical Framework Educational theory was incorporated into all stages of the IMM program development to promote optimal behavior change. The Stages of Change model was first described by Prochaska and DiClemente to explain behavior change in smokers.[25] The Stages of Change theory postulates that self-changing individuals move through a series of 5 stages to change a behavior: precontemplation, contemplation, preparation, action, and maintenance. The second main dimension of the Stages of Change model is the 10 processes of change. These processes help explain how people shift from one stage to another as well as provide avenues to help individuals move toward a higher stage. Over the last decade, the model has been applied extensively to nutrition education.[26–31] However, its application has been limited in computer-based nutrition education programs, especially IMM computer programs.

Objectives There were three primary objectives. The first objective was to develop the IMM module "Make a Great Start" based on the *La Cocina Saludable* curriculum and Prochaska and Di Clemente's Stages of Change theoretical model for use with low-income Hispanic clients. The second objective was to develop computer-based assessment tools and test the tools for reliability and validity. The final objective was to evaluate the "Make a Great Start" module using the computer-based assessment tools to determine its effectiveness in increasing knowledge, attitude, and stage of change scores among the target population. The null hypotheses were that there would be no difference from pre- to post-test in percent means and that there would be no difference in mean scores (post-test % to pretest %) between the intervention group and the control group.

METHODS

Module Development The "Make a Great Start" unit was adapted to IMM format through a multistep process that included the development of scripts, storyboards, graphics, translations, and audio. All key concepts from the original unit were included in the IMM module. Graphics were added to convey key messages and reduce the length of the unit.

Several processes of change from Prochaska's Stages of Change model were incorporated throughout the program. For example, questions were asked in each module to raise consciousness about dietary behavior, especially for participants in the precontemplative and contemplative stages. The unit also emphasized the benefits and barriers of eating break-

fast to address decisional balance. Emotional arousal/dramatic relief was addressed by emphasizing the importance of nutrition for family members, especially for children. Finally, self-efficacy was incorporated by including activities to practice skills such as reading food labels and choosing foods from different sections of the Food Guide Pyramid.

A second IMM program (budgeting module) was developed for the control group that covered general budgeting topics, such as setting goals, figuring income and expenses, and suggestions for reducing expenses. The program contained the same components as the "Make a Great Start" module, including graphics, audio, and buttons to move between the sections of the program. Furthermore, the program was approximately 15 minutes long, the same length as the "Make a Great Start" module. The purpose of the budgeting program was to present information not related to nutrition, using a format similar to the one used in the "Make a Great Start" module. This was done to minimize the effects of differences in computer skills between the intervention and control groups. There was no overlap in the content of the 2 modules.

Questionnaire Development A computer-based questionnaire was developed to assess the participant's knowledge, attitude, and stage of change (dependent variables) relating to breakfast. An example is displayed in the Figure. Each question and all responses were presented on the computer using text, graphics, and audio. No reading skills were required to answer the questions. Participants indicated their response by touching the appropriate answer on the computer screen. Questions addressing key concepts were included in the IMM module. The original questionnaire included 7 knowledge, 3 attitude, and 4 behavior questions, as well as 1 question concerning barriers to eating breakfast and 1 multipart question to assess the participant's stage of change. Stage of change was assessed using the general question, "Do you eat breakfast?" Based on the participant's response, further questions were asked to determine the duration of the behavior or intention to eat breakfast.

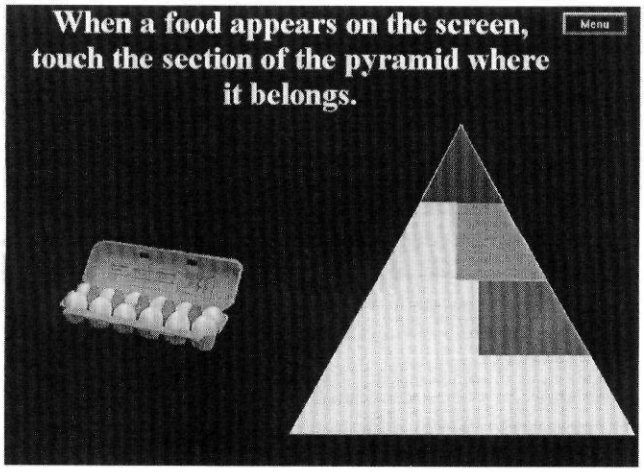

Figure. Sample screen from the computer-based assessment tool of the "Make A Great Start" module of *La Cocina Saludable* interactive multimedia nutrition education program.

The evaluation questions were tested for both reliability and validity. Reliability was assessed using the test–retest method (n = 18). Participants were recruited at English as a Second Language (ESL) and parenting classes at a family learning center. Participants were given the questionnaire once (test) and again 7 to 10 days later (retest). Content validity was measured by presenting the instrument to an IMM development team and to the professionals and paraprofessionals who used the original *La Cocina Saludable* curriculum. Criterion validity of the knowledge questions was established by administering the evaluation questions to students taking upper-level classes in the Department of Food Science and Human Nutrition at Colorado State University and members of the target audience. Upper level was defined as a senior or graduate course, indicating a broad base of nutritional knowledge. Comparison data from the target audience came from the test portion of the previously described reliability assessment. The two groups were used to determine if the question could distinguish between someone who was knowledgeable about nutrition and someone who was not knowledgeable. All evaluation protocols were approved by the Human Research Committee at the sponsoring institution.

Module Evaluation Evaluation of the "Make a Great Start" module consisted of both formative and summative processes. Formative evaluation took place throughout the development phase. Members of the development team consistently provided feedback relating to the content, graphics, and presentation of the material. A worksheet listing each screen of the "Make a Great Start" program was used to organize all feedback. Once an initial version of the program was completed, two groups evaluated the module: upper-level nutrition students and the professionals and paraprofessionals who are familiar with the *La Cocina Saludable* program and research project. Both groups were asked to complete a 2-page formative evaluation survey. The first page of the survey included 5-point Likert scale questions regarding flow, program speed, usefulness and value of the activities, ease of navigation, and quality, understandability, and effectiveness of the graphics and messages. The second page of the survey included open-ended questions about what the user liked and disliked, what the user remembered most, suggestions for improvement, and comments.

The efficacy of the program (summative evaluation) was evaluated using a quasi-experimental pretest, post-test control group design. The program was tested with the target population at 5 sites throughout the state of Colorado, ranging from 5 to 15 participants per site. Evaluation sites included county health departments, Special Supplemental Nutrition Program for Women, Infants and Children (WIC) clinics, and ESL classes. Sites were selected based on the number of low-

income and Spanish-speaking clients to assess both the English and Spanish versions. Only sites with a predominantly Hispanic low-income population were selected. Each site was determined to be an intervention or a control site, equally distributed between northern and southern Colorado. Participants were recruited by personal contact at the individual sites. Although the program was targeted at low-income and Hispanic mothers, any person over the age of 18 who had children was asked to participate. Over 80% of persons approached about the program agreed to participate in the research study. The research design was identical between the experimental and control groups, except for the IMM instructional module received. Each group received the computer-based demographics questionnaire, followed by the "Make a Great Start" computer-based assessment (pretest), followed by a 15-minute instructional module, followed immediately by the "Make a Great Start" computer-based assessment (post-test). For the instructional module, the experimental group received the "Make a Great Start" module, and the control group received the budgeting module. This was the only difference in the experimental design between the two groups.

On-line tracking data were collected as each participant moved through the program. The computer recorded every program button that a participant touched; thus, it was possible to obtain extensive data. Average time to complete (for each questionnaire and the module), number of on-screen buttons touched, and depth of exploration at specific points throughout the unit were analyzed. On-line tracking data were used to determine which parts of the program were most accessed and the expected time to complete the module and evaluations.

Statistical Analysis A combination of Microsoft Access, Microsoft Excel (Microsoft Corp, Seattle, Wash), and SPSS for Windows (SPSS Inc, Englewood Cliffs, NJ) was used to analyze the data. Microsoft Access was used to create the database and calculate on-line tracking data. Microsoft Excel was used to enter the data into a spreadsheet. The data were imported into SPSS and were analyzed using paired t tests, independent sample t tests, chi-square tests, McNemar chi-square tests, and repeated-measures analysis of covariance (ANCOVA).[32] The level of significance for all tests was set at .05. A stepwise regression analysis was performed to determine the significance of demographic characteristics and control versus intervention (independent variables) on post-test results. None of the demographic characteristics (including language, education, income, use of food assistance programs, and whether the participant had children 5 years of age or younger) were found to be significant covariates; therefore, the only covariate retained was the pretest score.

RESULTS

Reliability and Validity of the Evaluation Questionnaire Eighteen participants completed both the test and retest components of the computer-based evaluation questionnaire to test its reliability. A total test score and a total retest score were calculated for each participant. A paired t test between the test and retest scores resulted in a correlation coefficient of .932 ($P < .001$). The mean total test score was 16.52 (SD = 6.9) and the mean total retest score was 16.11 (SD = 7.2) of a possible 34 points. Furthermore, percentage agreement was calculated for each evaluation question. Only questions with a percentage agreement above 80% (13 of 15 questions) were kept in the final questionnaire.

To establish the criterion validity of the knowledge questions, 29 members of the target population and 25 upper-level nutrition students completed the evaluation questionnaire on the computer. Mean scores were calculated for each question for each group, and the group means were compared using independent sample t tests for each question. There were significant differences between the 2 groups ($P < .05$) for all questions except one, indicating that the questions could distinguish between someone who was knowledgeable about nutrition and someone who was not knowledgeable.

Formative Evaluation Twenty upper-level nutrition students and 5 professionals or paraprofessionals who use the *La Cocina Saludable* program completed the 2-page formative evaluation survey. Overall, responses were very positive, averaging 4.3 on a 5-point Likert scale for all objective questions. Adjustments were made based on the results, including improving several graphics to clarify concepts, increasing the speed slightly, adding audio prompts to improve the flow of the program, and activating several navigation buttons to give the participant more choice as he or she moved through the program.

Summative Evaluation: Demographic Characteristics Thirty-six participants were included in the intervention group and 34 in the control group. The program was specifically targeted at Hispanic and/or low-income mothers of preschool children receiving food assistance. Overall, the target population was reached. Both groups were primarily Hispanic and low income (less than US $15000 per year). They reported a high school education or less and had used nutrition assistance programs in the past. Additionally, only half of the total participants reported eating breakfast "on most days." Chi-square tests indicated that there were no significant differences in demographic characteristics between the "Make a Great Start" and control groups (Table 1).

"Make a Great Start" Module Impact The mean total pretest score was 51.1 for the intervention group and 51.5 for the control group. The intervention group significantly improved total score at post-test, with a mean of 83.3 ($P = .000$). The mean post-test score for the control group was 47.4 and was not significantly different from the pretest score ($P = .07$). In the intervention group ("Make a Great Start"), 94.4% of participants improved their combined knowledge and atti-

Table 1. Comparison of Intervention and Control Groups on Selected Demographic Characteristics (%)

	Intervention (n = 36)	Control (n = 34)	Differences (*P* Value)
Gender			
Male	0 (0.0)	3 (8.8)	.068
Female	36 (100.0)	31 (91.2)	
Location of birth			
United States	28 (77.8)	30 (88.2)	.246
Other country	8 (22.2)	4 (11.8)	
Children < 5 years old	25 (69.4)	20 (58.8)	.354
Pregnant	4 (11.1)	9 (26.5)	.064
Spanish speaking	15 (41.7)	13 (38.2)	.520
Education			
Less than 9th grade	5 (13.9)	4 (11.8)	.591
9th-12th grade	11 (30.6)	16 (47.1)	
Diploma or GED	8 (22.2)	7 (20.6)	
Some college credit	8 (22.2)	4 (11.8)	
Bachelor's degree	3 (8.3)	1 (2.9)	
Other	1 (2.8)	2 (5.9)	
Yearly household income			
< $10 000	14 (38.9)	16 (47.1)	.201
$10 000-$15 000	6 (16.7)	8 (23.5)	
$15 001-$20 000	5 (13.9)	7 (20.6)	
$20 001-$30 000	8 (22.2)	3 (8.8)	
> $30 000	3 (8.3)	0 (0.0)	
Unemployed	8 (22.2)	6 (17.6)	.839
No. of persons income supports			
1-3	12 (33.3)	19 (55.9)	.088
4-6	22 (61.1)	15 (44.1)	
> 6	2 (5.6)	0 (0.0)	
No. of persons income feeds			
1-3	12 (33.3)	13 (38.2)	.560
4-6	21 (58.3)	16 (47.1)	
> 6	3 (8.3)	5 (14.7)	
Use of assistance programs*			
WIC	21 (58.3)	22 (64.7)	.584
Head Start	12 (33.3)	9 (26.5)	.531
Food Stamps	13 (36.1)	18 (52.9)	.157
School Breakfast/Lunch	13 (36.1)	13 (38.2)	.854
EFNEP/FSNEP	0 (0.0)	0 (0.0)	
CSFP	10 (27.8)	4 (11.8)	.094
SHARE Colorado	6 (16.7)	4 (11.8)	.558
Migrant Health Services	0 (0.0)	1 (2.9)	.300
Total (use 1 or more)	31 (86.1)	32 (94.1)	.264

*WIC indicates Special Supplemental Nutrition Program for Women, Infants and Children; EFNEP, Expanded Food and Nutrition Education Program; FSNEP, Food Stamp Nutrition Education Program; CSFP, Commodity Supplemental Food Program.

tude score from pretest to post-test. In the control group, only 14.7% of participants improved their score from pretest to post-test. Approximately 32% of control participants decreased their score from pretest to post-test. No significant differences in knowledge, attitude, or total pretest scores were seen between the intervention and control groups. Table 2 shows the percent knowledge, attitude, and total scores at pretest and post-test for the intervention and control groups.

Overall, significant differences in outcome measures ($P < .001$) were attributed only to the participant's group

Table 2. Comparison of Pre and Post Mean Knowledge, Attitude, and Total Scores Within the "Make A Great Start" Participants and the Control Group* Using ANCOVA, % ± SEM

	Pretest Scores	Post-test Scores	*P* Value
Knowledge scores			
Control group	36.275 ± 4.191	30.882 ± 3.384	.133
Intervention group	30.556 ± 3.287	79.630 ± 3.878	.000
Attitude scores			
Control group	74.265 ± 4.154	72.059 ± 4.449	.083
Intervention group	81.944 ± 4.297	88.889 ± 3.914	.006
Total scores			
Control group	51.471 ± 2.868	47.353 ± 2.681	.070
Intervention group	51.111 ± 2.445	83.333 ± 2.391	.000

*Control group (n = 34); intervention group (n = 36).

(intervention versus control). Broken down by category, significant differences were seen in mean knowledge, mean attitude, and mean total scores between groups. Power calculations were used to determine whether enough statistical power was available to detect real differences between the "Make a Great Start" and control groups in adjusted post-test knowledge (100% power), attitude (95.9% power), and total scores (100% power).

The most significant changes in the intervention group from pretest to post-test were seen in knowledge scores. Knowledge scores were reported as the percent correct responses. The mean knowledge scores increased from 30% correct at pretest to 80% correct at post-test in the intervention group. Because the increase was so high, the knowledge score was reanalyzed by individual question using McNemar's chi-square tests. When analyzed by question, each question significantly improved from pretest to post-test only in the intervention group.

There was not a significantly greater increase in the participant's stage of change (as measured by the previously described multipart question) in the intervention group when compared with the control group. However, a trend toward greater increases in stage of change was seen in the intervention group when controlled for demographic characteristics and pretest score ($P = .055$). In the "Make a Great Start" group, 22.2% of participants increased their stage of change from pretest to post-test. Only 2.9% of control participants increased their stage of change.

On-line tracking data were analyzed to determine the average time for each component and interactivity as measured by the average number of program buttons or objects touched. The average time taken to complete the "Make a Great Start" module was approximately 15 minutes. The average time to complete each of the demographic and "Make a Great Start" computer-based questionnaires was approximately 2.5 minutes. The average number of buttons or objects touched in the "Make a Great Start" module was 49, indicating extensive interaction.

DISCUSSION

On-line Evaluation Tools On-line data analysis showed that the average completion time for the "Make a Great Start" module was approximately 15 minutes. Furthermore, both the demographics questionnaire and evaluation questionnaire took approximately 2.5 to 3 minutes. The completion time for IMM delivery is shorter than the time for delivery by an educator. This may be especially applicable to overcoming the barriers to nutrition education among low-income and Hispanic persons. Barriers that have been noted include conflicts with work or school, lack of transportation, and child care. Interactive multimedia not only decreases time but also may by used within a food assistance clinic in the presence of children, thus eliminating additional transportation and child care needs.

Completing the demographics and evaluation questionnaires on the computer saves time and may eliminate some of the anxiety associated with a paper and pencil evaluation tool. A general discontent with evaluation instruments has been reported by many researchers.[22,33–35] Completing the evaluation on the computer may be less intimidating, especially for low-literate audiences. This was especially true in this study because audio files were used to relate all questions and possible responses to the participant. No reading skills were required to answer the questions. Furthermore, a brief demonstration was given and a practice question was included in the demographics questionnaire to decrease anxiety. A few participants commented on how much they liked the computer-based assessment. They felt that it was quicker and more private than completing an assessment on paper. The challenges of computer-based evaluation include the initial time and cost-intensive nature of assessing validity and reliability. Specifically, limited computer access for testing and recruiting participants for the test and retest portions made assessing reliability and validity difficult. However, the benefits of computer-based assessments appeared to overcome the drawbacks. These results are of interest since few nutri-

tion education interventions have used the computer for demographic and evaluation questionnaires.

Effect of "Make a Great Start" Module on Knowledge and Attitude Scores It was noted that only half of the total participants ate breakfast "on most days." This confirms the need for nutrition education about breakfast in this population. Overall, the "Make a Great Start" module was effective in increasing knowledge and attitude scores about breakfast among program participants. Over 94% of participants improved their total knowledge and attitude score from pretest to post-test. Given the magnitude of the differences, it is unlikely that the 3 men in the control group influenced the results. On average, the participants increased their knowledge scores from 30% at pretest to 80% at post-test. This finding was similar to that reported by Taylor and colleagues when measuring knowledge change among participants who were taught the *La Cocina Saludable* curriculum by an *abuela* trained as a nutrition educator.[22] These results indicate that IMM format is a comparable alternative to nutrition education taught by an *abuela*. The magnitude of knowledge increases was higher than reported by Gould and Anderson.[8] This study examined the effectiveness of adapting the first 2 modules of the *La Cocina Saludable* curriculum to an IMM format. There are several possible explanations for the greater knowledge increases seen in participants exposed to IMM versus the classroom version, including the incorporation of interactive activities and the addition of a review section to reinforce key concepts.

Other research projects using IMM have shown similar positive increases in knowledge and/or attitude scores following an intervention. Campbell and colleagues reported significant increases in knowledge of low-fat foods and self-efficacy among participants completing the Stamp Smart program, a nutrition education program targeted at low-income, high-risk audiences.[12] Furthermore, Carroll and colleagues reported improvement in 67% of responses from pretest to post-test among participants using an IMM nutrition education program.[13] The results from these studies, in conjunction with those from the current study, suggest that IMM is an effective tool for increasing nutrition-related knowledge among low-income persons.

Stage of Change Theory-driven nutrition education has been shown to improve behavior.[36] Specifically, Prochaska and colleagues' Stages of Change model has been successfully applied to nutrition interventions to change dietary behavior.[26-31] In this study, significantly greater increases in stage of change were not seen among program participants when compared to controls. This is not surprising, however, when considering the intensity and duration of the program. According to Prochaska and colleagues, movement through the stages is a function of time.[37] For many addictive behaviors, change may take from months to years. Brug and colleagues reported similar insignificant changes in behavior following computer-tailored intervention.[15]

Although the instrument used to determine the participant's stage of change was tested for reliability and validity, it may not have measured the participant's stage of change accurately. In the summative evaluation, the results indicated that 4 of 36 participants in the intervention group moved from the precontemplative stage at pretest to the action stage at post-test. This is very unlikely, considering the duration and content of the program. The inherent nature of self-report or the tendency to report desired behavior change instead of actual behavior changes may have caused these discrepancies. This is often referred to as the "yeah-saying" phenomenon. More extensive questions are likely needed to determine a participant's stage of change and movement in stage from pretest to post-test. This study showed that assessing stage of change may be feasible using IMM; however, a participant's stage of change must be measured over a longer period of time.[25,26,28-31]

Limitations There were 4 limitations of this study that should be noted. First, the participants were not randomly assigned to experimental or control groups. The study used a convenience sample from the preselected sites. Participants could refuse participation; therefore, equal numbers were not obtained at each site. Potential differences between demographic characteristics and evaluation site were tested and found to be insignificant. Second, all information received from participants was self-reported. Although the instruments used were reliable and valid, there was no way to confirm the accuracy of the participants' responses. Language of choice, rather than ethnicity, was the criterion used to assess the effectiveness of both the English and Spanish versions. This variable was chosen to ensure an adequate number of participants to evaluate the Spanish version of the program. Limited representativeness was another limitation of the study. Data were collected during the winter and early spring, from December through April. In Colorado, seasonality affects the availability of certain members of the target population. Specifically, Hispanic migrant farm workers, who are prominent in Colorado during the summer months, were not included in this study. Finally, owing to small sample size and nonrandomized design, the results of this study may not be generalized to other populations.

IMPLICATIONS FOR RESEARCH AND PRACTICE

Overall, IMM is a comparable alternative to other methods of delivering nutrition education. The use of IMM conveys several advantages over other methodologies. A primary advantage is the ease of access owing to computers that are positioned in waiting areas of agencies serving low-income populations. In the future, computers will be positioned in other community settings where people congregate, such as laundromats, churches, and community centers. Other advantages include decreased instructional time, which helps to

overcome transportation and child care barriers, cost effectiveness, incorporation of interactive games and activities, and the use of computer-based evaluations that require no reading skills.[8]

The use of computer-based evaluations may be especially valuable for low-income and low-literate populations. Computer evaluations decrease both participant completion time and researcher analysis time. Additionally, participants may feel less intimidated by completing a questionnaire on the touch-screen computer. Questions with multiple parts can be easily programmed on a computer so that the participant only answers relevant questions. Each of these advantages is important to overcome the discontent with paper-based assessments and literacy barriers to evaluating the effectiveness of nutrition education programs for low-income and low-literate Hispanic persons.

Future research should concentrate on the development and evaluation of a computer-based tool to measure behavior change in the target population. Although the results of this study showed highly significant changes in knowledge and attitude after using the module, a complete evaluation would ideally include a behavior component. It would be interesting to determine the effects of the program long term on dietary behavior. Possible evaluation tools might include a food frequency questionnaire or a 24-hour recall survey adapted for use with IMM. The addition of a tool to measure behavior change would enhance the reported effectiveness of the module. Furthermore, it would increase the scope of its use in nutrition assistance programs as many programs require a behavior measurement as part of program evaluation.

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