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Pilot Using World Wide Web to Prevent Diabetes in Adolescents

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This pilot study tested the effects of an interactive nutrition education Web site on fruit, vegetable, and fat consumption in minority adolescents genetically at risk for Type 2 diabetes. A one-group nonexperimental pretest, posttest focus group design was used. Twenty-one sixth-grade to eighth-grade junior high adolescents who were minorities volunteered to participate. Participants received 5 hours of Web-based nutrition education over 3 weeks. A significant difference in fat consumption was supported from the computerized dietary assessment. No difference was found in fruit or vegetable consumption. Comparative data indicated a rise in body mass index (BMI) percentile from 88.03 (1999) to 88.40 (2002; boys) and 88.25 (1999) to 91.2 (2002; girls). Focus group responses supported the satisfaction of adolescents in the study with the use of the Web-based intervention for nutrition education. Healthy eating

interventions using Web-based nutrition education should be further investigated with adolescents.

Keywords: *diabetes and nutrition education; WWW; adolescents*

The incidence of childhood and adolescent obesity has risen at an alarming rate. Approximately 15.5% of U.S. youth age 12 to 19 years is overweight, with the prevalence of overweight being significantly higher among youth who are minorities (Centers for Disease Control and Prevention [CDC], 2003a; McLennan, 2004). Diabetes affects 18 million Americans, and the number of people with diabetes worldwide is expected to double by 2030 (Wild, Roglic, Green, Sicree, & King, 2004). Obesity is the leading modifiable risk factor of Type 2 diabetes, and evidence supporting the link between obesity, poor dietary habits, and the early-onset of this disease is growing (CDC, 2003a; T. K. Young, Dean, & Flett, 2000). Healthy eating practices are known to be significant in the prevention of being overweight and obesity in youths, and behavioral interventions relevant to the social preferences and developmental stage of adolescents are needed. This pilot project tested the effectiveness of an interactive World Wide Web (WWW)–based nutrition education intervention on healthy eating in adolescents who were minorities.

Diet, Development, and Type 2 Diabetes in Adolescents

Of the 20 million adolescents in the United States, more than 60% exceed the daily recommended fat intake, and less than 20% eat the recommended five servings a day of fruits and vegetables (CDC, 2003a). Poor dietary patterns formed in childhood and adolescence tend to extend into adulthood, placing youth at risk for early-onset of Type 2 diabetes; and, therefore, the initiation of prevention programs has been identified as a public health priority (CDC, 2003a; R. S. Young & Rosenbloom, 1998).

The developmental stage of adolescence poses unique challenges for health educators, and research supports the acceptance of technology-based

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instruction in this population. Computer-based instruction provides increased learner control, independence, and decision making, making it an effective method of instruction sensitive to the learning preferences of youth (Chewning, Mosena, & Wilson, 1999; Long & Stevens, 2004; President's Committee of Advisors, 1997; Shegog, Bartholomew, & Parcel, 2001).

Self-efficacy (SE) theory has been extensively utilized as a construct in explanatory models of health behavior and is described as a generative capability in relationship to one's social, environmental, cognitive, and personal circumstances (Bandura, 1997; Parcel, Edmundson, & Perry, 1995). Research reporting the effectiveness of technology to promote SE for healthy behaviors in adolescents has been reported (Long & Stevens, 2004; Shegog et al., 2001). The instructional elements known to stimulate SE—self-assessment and feedback, repetition, mastery, and modeling—were embedded in the intervention to facilitate a change in adolescent eating behavior. Changes in SE for healthy eating were not measured in this pilot study.

Purpose

The purpose of the current study was to develop and test the effects of an interactive WWW-based nutrition education intervention on fruit, vegetable, and fat consumption in adolescents who were minorities. A secondary study aim was to compare body mass index (BMI) data from a 1999 and 2002 sample.

The study hypotheses were the following:

Adolescents receiving behavioral instruction from the Diabetes Prevention Web site will have (*Hypothesis 1*) an increased number of fruit choices, (*Hypothesis 2*) vegetable choices, and (*Hypothesis 3*) a decreased number of fat choices at posttest as compared to pretest.

The two research questions were as follows:

Research Question 1: What risk factors are present for Type 2 diabetes in this population?

Research Question 2: Are adolescents satisfied with using the WWW to learn about Type 2 diabetes prevention?

Design

A one-group nonexperimental pretest, posttest focus group design was used.

Sample

A random sample of 60 adolescents, age 12 to 16 years, was selected from a population of 118 students who were minorities enrolled in a junior high school volunteering to participate in the study in a southwestern state. Participants needed to be able to read well enough to understand the instructions and content in the Web-based intervention. The readability of the intervention content was estimated and inclusion criteria requiring a sixth-grade reading level were set. Standardized reading test scores provided by the school indicated that approximately one half of the randomly selected students who were minorities fell below the sixth-grade reading level. To continue the study, a volunteer sample of 21 students was recruited who met the study criteria from the original random sample. The demographic data from the sample indicated 12 students were male (57.1%) and 9 (42.9%) were female. Racial distribution was Hispanic (57.1%), African American (33.3%), and mixed ethnicity (9.5%). The mean age of students was 13 years.

Method

The procedures and protocols for the current study included approval by the University Institutional Review Board (IRB) and the IRB of the Independent School District of the city in which the school was located. Permission was obtained from the school principal, and a schedule was arranged with the computer teacher and librarians to allow for student use of the Internet-connected computers before school. Information letters explaining the study were sent home with eligible students, and parent and/or legal guardian consent and adolescent assent were obtained.

When students were enrolled in the current study, demographic and anthropomorphic information, BMI, and family history of diabetes were collected. Fruit, vegetable, and fat consumption were measured by two assessment methods. A modified, 24-hour dietary recall was obtained through a verbal structured interview at Time 1 and 2 by trained members of the research team. Assessing dietary intake through dietary recall has been widely used, and reliability has been reported to be acceptable in making inferences about eating patterns in youth (Edmundson, Parcel, & Feldman, 1996; Wylie-Rosett, Wassertheil-Smoller, & Elmer, 1990). Students were next assigned humorous passwords such as *chili pepper* and *green olive* from a list of fruits and vegetables and were instructed to log onto the Web site where they were prompted to take a short, computerized version of a modified 24-hour dietary recall. Eleven questions from an existing Web-based dietary

assessment were modified to reflect a 24-hour dietary recall period and used to estimate self-reported fruit, vegetable, and fat consumption (University of Tennessee Agriculture Extension Service, 2002). Using data from the study population, the computerized 24-hour dietary recall reliability estimates at pretest and posttest were found to be acceptable for fat ($r = .56$, $p < .05$), fruits ($r = .46$, $p < .03$), and vegetables ($r = .46$, $p < .03$) and comparable to existing adolescent dietary assessments (Rockett, Breitenbach, Frazier, & Witschi, 1997; Rockett, Wolf, & Colditz, 1995).

The diabetes prevention intervention consisted of an educational Web site tailored to the social and developmental preferences of adolescents. Building on recommendations from the CDC (1996), the WWW-based nutrition education experience was designed to be age relevant, fun, and participatory—capturing adolescent attention while allowing individual control over the pace of learning. The Web site utilized an "edutainment" approach to learning by blending education and entertainment. Nutrition education important for diabetes prevention was delivered through the use of Web sites linked to interactive nutrition games, dietary self-assessment measures, and informational Web sites. Educational objectives for the intervention consisted of nutrition information on fruits, vegetables, and fat intake; exercise; and diabetes content that challenged the adolescents to assess and evaluate their personal diabetes knowledge, beliefs, and health practices. Selection of the content offered on the Web site and Web links was made by the research team. All WWW links embedded in the intervention were rated using the Stevens/Long Website Rating Scale (Stevens & Long, 2000) and had been determined to have acceptable quality, content, and readability and be developmentally appropriate for adolescents. A summary of intervention content and the Web sites used are listed in Table 1.

The development, design, and programming of the Web site were completed by the study Webmaster using HTML, JavaScript, PHP, and Flash Action Scripting. The software included Macromedia Web Design Studio 4 and Adobe Photoshop 6.0. Reliability of the Seca scale was determined by test-retest in a volunteer sample of 15 college students enrolled in a summer course. Using Pearson's r correlation, the stability of the scale for weight was $r = 1.000$, $p < .001$, and for height was $r = .999$, $p < .001$. The RJL equipment for bioelectrical impedance was tested through repeated measure on four students, $r = 1.000$, $p < .001$ (RJL Systems, 2002).

The intervention was delivered to students in the school's computer classroom 45 minutes before school began over a 3-week period. Attendance was recorded, and participants averaged 5 hours of exposure to the intervention during the study period. Students logged onto the Web site by entering the "control room." This Web page had a space-station look in which the learner

Table 1
Web Site Links Within the Intervention and Summary of Content

Web Site URL	Content
http://www.schoolmenu.com/homepage.htm	healthy eating games, puzzles, and riddles for youth
http://www.kidshealth.org/	staying healthy and recipe links used; focus: staying fit while having fun
http://www.exhibits.pacsci.org/nutrition/nutrition_cafe.html	youth learn about nutrition information while having fun playing the Grab a Grape or Nutrition Sleuth games or explore the Have a Bite café
http://www.dole5aday.com/	interactive nutrition Web site for youth presenting games, quizzes, and activities promoting fruit and vegetable intake
http://www.nal.usda.gov/fnic/Fpyr/pmap.htm	interactive food guide pyramid focused on food categories and serving size
http://www.cdc.gov/nccdphp/sgr/adoles.htm	information on physical activity and health for adolescents and young adults
http://www.diabetes.org/risk-test.jsp	diabetes risk test—self-assessment of diabetes risk factors
http://www.joslin.harvard.edu/	diabetes prevention education information for teens

could choose to go to the "kitchen" or "gym" while listening to contemporary music with a raplike beat. The pages were colorful and modern in design offering multiple choices of links to games, Web quests, quizzes, and information. Elements included the use of a variety of age-appropriate sound bites and provided for immediate feedback in many of the games and opportunities to earn points, race for best time, and compete with oneself or peers.

Data Analysis

Statistical analysis of Hypotheses 1, 2, and 3 was performed using SPSS, version 10. Paired *t* tests were run using pretest and posttest scores for fruit, vegetable, and fat intake from the 24-hour dietary recall and from the computerized version of the dietary recall. Measures of central tendency were used to analyze diabetes risk factors. Qualitative assessment of adolescent satisfaction was conducted by observation of adolescent behavior during the study period and through focus groups after the completion of the intervention.

Table 2
Mean Fruit, Vegetable, and Fat Scores, Pretest and Posttest

	Pretest *M* (*SD*)	Posttest *M* (*SD*)	Mean Difference
Structured interview			
Fat[a]	15.26 (10.59)	15.89 (8.57)	.63
Vegetable[a]	1.07 (1.24)	1.05 (.86)	-.02
Fruit[a]	1.31 (1.22)	1.69 (1.48)	.38
Soda	.95 (.92)	1.05 (.86)	.10
Web-based assessment			
Fat[a]	16.10 (3.62)	14.48 (3.72)	-1.62*
Vegetable[a]	2.33 (1.02)	2.19 (1.03)	-.14
Fruit[a]	2.67 (1.11)	2.52 (.93)	-.15
Soda	2.90 (1.07)	2.75 (.85)	-.15
Read nutrition labels	1.70 (.57)	1.70 (.57)	.00
Exercise[b]	4.55 (.94)	4.40 (1.14)	-.15

a. $n = 21$.
b. $n = 20$.
*$p < .05$.

Findings

A significant difference between Time 1 and 2 was found in fat intake in the computerized dietary assessment ($t = 2.16$, $p < .04$, $df = 20$). No significant difference was found in fruit or vegetable scores by either measurement. Mean fruit, vegetable, and fat scores varied in direction based on measurement and are located in Table 2. The scores from both instruments were correlated to explore convergent validity of the two methods. A small-to-medium correlation was found between dietary measurements (fat, $r = .33$, $p < .13$; fruit, $r = .32$, $p < .15$; vegetable, $r = .48$, $p < .03$).

Family history and BMI risk factors for Type 2 diabetes were also examined. Three (14%) reported having diabetes present in a father, mother, sister, or brother. Anthropomorphic data and BMI were measured. Values were plotted using the CDC BMI for age percentiles for boys, and for girls, 2 to 20 years (CDC, 2000). The mean BMI percentile for the pilot group was 88.4 for boys and 91.2 for girls. A 1999 data set from a prior study in the same school was available, and the changes in BMI over time in this population were compared (J. D. Long, personal communication, March 2003). Using self-reported height and weight from 58 randomly selected adolescents who were minorities, each participant's BMI was calculated. Mean BMI percentile increased for boys from 88.03 (1999) to 88.40 (2002) and for girls 88.25 (1999) to 91.2 (2002) and are listed in Tables 3 and 4.

Table 3
Age, Gender and Body Mass Index (BMI) for Boys and Girls for 1999

		Overweight		At Risk		Acceptable
Number of Participants	Age	> 97%	> 95%	> 85%	< 95%	< 85%
1999 Boys						
8	12	0	0	3		5
12	13	0	2	1		9
8	14	2	0	2		4
2	15	1	0	1		0
Total: 30		3	2	7		18
		(10%)	(6.7%)	(23%)		(60%)
		1999 Mean BMI Percentile for Boys: 88.03				
1999 Girls						
12	12	1	2	5		4
8	13	1	0	1		6
7	14	1	0	1		5
1	15	0	0	0		1
Total: 28		3	2	7		16
		(10%)	(7%)	(25%)		(57%)
		1999 Mean BMI Percentile for Girls: 88.25				

The second research question sought to evaluate the satisfaction and utility of the Web-based Type 2 Diabetes Prevention Web site for adolescents. The research team recorded behaviors, statements, and comments or requests from all students and categorized participants as "game players," "peekers," and "soloists" described in Table 5.

Discussion

Exposure to the Web-based intervention resulted in a significant decrease in fat consumption when measured by the computer-based dietary assessment. These findings are consistent with others reporting a significant decrease in fat consumption after a modest nutrition education with adolescents (Frenn, Malin, & Bansal, 2003). A significant difference in fat consumption was not found when measured by a structured-verbal modified 24-hour recall, and there are several possible explanations for this finding. The tendency of students to overreport when first responding to dietary questionnaires may contribute to difficulty in detecting a significant change at posttest (Welten,

Table 4
Age, Gender, and Body Mass Index (BMI) for Boys and Girls for 2002

		Overweight		At Risk		Acceptable
Number of Participants	Age	> 97%	> 95%	> 85%	< 95%	< 85%
2002 Boys						
5	12	0	1	0		4
2	13	1	0	0		1
2	14	0	0	0		2
1	15	1	0	0		0
Total: 10		2	1	0		7
		(20%)	(10%)			(70%)
		2002 Mean BMI Percentile for Boys: 88.4				
2002 Girls						
1	12	1	0	0		0
3	13	0	0	1		2
5	14	2	1	1		1
0	15					
Total:	9	3	1	2		3
		(33%)	(11%)	(22%)		(33%)
		2002 Mean BMI Percentile for Girls: 91.20				

Carpenter, & McPherson, 2000). Thompson and Byers (1994) described the 24-hour dietary recall as having mixed results when compared with diet records for the same individuals. Respondents with lower observed food intake tended to overreport, and underreporting was observed in those with higher intakes; multiple 24-hour recalls are often used to more accurately estimate diet. Time constraints related to the end of the school year and availability of students prompted our decision to use a single modified 24-hour dietary recall at Time 1 and 2 to estimate changes in eating behavior. Our findings suggest the need for replication of the intervention using a larger sample size and the average of multiple 24-hour recalls along with the computerized method.

Our data did not support a significant change in fruit and vegetable consumption when measured by either method of dietary assessment. Because fewer fruits and vegetables are consumed than fat servings, it is more difficult to detect changes with these food groups. Measurements that are sufficiently sensitive to detect small, but important, changes in fruit and vegetable intake are needed. Newly developed dietary assessment tools have been reported and are important for future research (Van Assema, Burg, & Ronda, 2002). In

Table 5
Summary of Qualitative Observations

Category	Behaviors	Statements	Requested
"Game players"	Arrived early	"Playing the games was fun"	More music choices
	Asked to stay late	"I learned a lot from playing"	More games and competitive quizzes
"Peekers"	Attended regularly	"I learned a lot—like how to make a perfect salad, and that fruit pie doesn't count as a fruit on the food guide pyramid"	No specific requests
	Influenced by peers		
	Less likely to initiate exploration of Web site on own		
	No specific requests		
"Soloists"	Chose to sit at computer stations away from others	"I am glad I learned about how to prevent diabetes"	No specific requests
	Worked quietly on the intervention		
	Did not appear as enthusiastic as others		

the current study, the intervention time may need to be lengthened to realize a significant fruit and/or vegetable change.

Students were satisfied with the Web-based intervention to learn about nutrition and diabetes prevention. Students returned to the Internet links that offered a gamelike approach to learning. This observation was consistent with the recommendations of the CDC suggesting that an interactive, computer-based method of nutrition education is a relevant and socially appropriate method of learning for adolescents (CDC, 1996).

Our findings supported an increase in the number of boys and girls in the overweight category from 1999 to 2002 (CDC, 2003b). The findings, however, are limited given the difference in methods used in each data set. These findings from the overweight category are consistent with findings from the National Hispanic Health and Nutrition Examination Surveys indicating a

trend of the youth who are heaviest becoming heavier, especially Mexican American and non-Hispanic Black adolescents (Baumgartner, Roche, & Guo, 1990; Ogden, Flegal, & Carroll, 2002). This trend combined with the presence of other known risk factors for Type 2 diabetes is a clinically significant finding in this small pilot study.

Application

Obesity and being overweight may be the most significant public health issue faced in the 21st century. Youth who are minorities are among those at highest risk for obesity, being overweight, and the subsequent development of Type 2 diabetes. Improving the eating behaviors of this population holds the potential of lifelong benefit. Adolescent response to the Web-based intervention in this pilot study was encouraging and suggests the need for study replication with a larger sample over a longer time before the effects of the intervention can be fully determined.

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