

Development and Evaluation of an Educational Intervention Program for Pre-professional Adolescent Ballet Dancers

Nutrition for Optimal Performance

Ashley F. Doyle-Lucas, Ph.D., and Brenda M. Davy, Ph.D., R.D., F.A.C.S.M.

Abstract

The purpose of this investigation was to develop, implement, and evaluate a theoretically based nutritional education intervention through a DVD lecture series (three 30-minute classes) in summer intensive programs for pre-professional, adolescent ballet dancers. Objectives of this intervention program were to increase knowledge of basic sports nutrition principles and the Female Athlete Triad and promote self-efficacy for adopting healthier dietary habits. Dancers ranging from 13 to 18 years old who were attending summer intensive programs affiliated with professional ballet companies were recruited. Group One ($n = 231$) participated in the nutrition education program, while Group Two the control participants ($n = 90$) did not. Assessments of the participants' dietary status consisted of a demographic questionnaire, a Sports Nutrition Knowledge and Behavior Questionnaire, and a Food Frequency Questionnaire. The intervention group was assessed at baseline, immediately post-program, and at six weeks post-program. The control group was assessed at baseline and at six weeks post-baseline. The intervention program was effective at increasing nutrition knowledge, perceived susceptibility to the Female Athlete Triad, and self-efficacy constructs. Improvements in dietary in-

take were also observed among intervention group participants. To improve overall health and performance nutrition education should be incorporated into the training regimens of adolescent dancers. This potentially replicable DVD-based program may be an effective, low-cost mechanism for doing that.

The physical demands placed on dancers are significant, as success is dependent upon both athletic capabilities and aesthetic factors.¹⁻³ In order to achieve the desired long, lean figure, ballet dancers often severely restrict dietary intake or engage in abnormal eating behaviors.^{2,4,5} Student and professional ballet dancers, particularly females, consume less than 70% to 80% of the recommended dietary allowance for total energy, and often weigh 10% to 12% below ideal body weight.⁵⁻⁹ The intense training and physical expectations placed upon dancers, particularly pubertal adolescents, requires significant energy consumption for optimal performance and adequate nutrient intake.^{10,11} Female athletes who participate in any sport where much importance is placed on

low body weight are at increased risk for developing the Female Athlete Triad (FT).¹²

Conditions of the FT, especially menstrual irregularities and low energy availability, are more prevalent in dancers than in lean pair-matched non-dancing control women.¹³ Despite having similar fat-free mass (FFM), body mass index (BMI), and age, dancers also demonstrate a significantly lower resting metabolic rate (RMR) and lower energy intake compared to lean, non-dancing women.¹³ The depressed absolute and RMR relative to FFM among dancers may result from a chronically low energy intake.⁵ This deficiency relative to predicted energy expenditure may increase energetic efficiency in female runners, gymnasts, and other athletes who restrict food intake to remain at a below natural weight,¹⁴ a phenomenon that has also been observed in female ballet dancers.¹³

The FT decreases optimal performance levels and poses significant health risks to female athletes. Negative consequences of this condition have yet to be shown to be reversible by pharmacological means.¹² While recognition and treatment of the FT should be a priority, prevention through nutrition and health education aimed at promoting healthy behaviors among young athletes is clearly needed.¹⁵ Previous work has concluded that increased knowledge of proper nutrition is essential.^{1,15-19}

Ashley F. Doyle-Lucas, Ph.D. is in the Department of Dance, The Ohio State University, Columbus, Ohio. Brenda M. Davy, Ph.D., R.D., F.A.C.S.M., is in the Department of Human Nutrition, Foods, and Exercise, Virginia Tech, Blacksburg, Virginia.

Correspondence: Brenda M. Davy, Ph.D., R.D., F.A.C.S.M., Department of Human Nutrition, Foods, and Exercise, 221 Wallace Hall (0430), Virginia Tech, Blacksburg, Virginia 24061; bdavy@vt.edu.

Yet, to date only one investigation has addressed nutrition education for dancers. Yannakoulia and colleagues evaluated the effectiveness of a nutrition intervention that combined education and primary prevention of disordered eating in a group of 32 dancers aged 19 to 25 years.²⁰ Program content was delivered through 12 weekly lessons including lectures, facilitated group discussions, and workshops. The program was found to increase nutrition knowledge and decrease abnormal eating behaviors among its participants.²⁰ These results are encouraging for the development of other education programs targeting adolescent ballet dancers who may be less educated about healthy eating behaviors and vulnerable to misinformation. However, a larger study population and the inclusion of a control group for comparison are necessary to evaluate the effectiveness of a program that could be replicated and implemented on a large-scale basis by dance organizations.

Similar programs have been implemented among other populations of young athletes. Chapman and associates evaluated the effectiveness of a sports nutrition education program (six 45-minute lectures) aimed at

changing the nutrition behavior of female athletes on high school softball teams.²¹ Although a significant increase in nutrition knowledge was reported, there was no change in dietary habits (food intake or food choices).²¹ Thus, it appears that increased nutrition knowledge and positive attitudes toward nutrition do not necessarily translate into healthier dietary behaviors.²¹⁻²³ Others have simply failed to improve nutrition knowledge, possibly due to limited program contact time and a large student-to-instructor ratio.²⁴

As an example of a successful program, ATHENA (Athletes Targeting Healthy Exercise and Nutrition Alternatives) consisted of eight 45-minute sessions for female high school students, which addressed such topics as healthy sport nutrition, effective training, and the effect of unhealthy behavior on sport performance.²⁵ The success of this intervention may be due in part to its inclusion of lectures concerning behavior modification.²⁵ Summer intensive programs for adolescent dancers are similar to this "sport team" environment and could support positive outcomes of an intervention focused on improving nutrition knowledge and eating habits. However, the culture of profes-

sional dance organizations, which may be at odds with promoting positive health behaviors due to emphasis on their dancers' lean physiques, must be considered in program development at that level.²⁶

An important aspect of devising a successful program with behavioral change as a desired outcome is the need to incorporate behavioral change theory,²⁷ such as the Health Belief Model (HBM)²⁸ and Social Cognitive Theory (SCT).²⁹ With health motivation as the underlying focus, the HBM is often used in programs addressing personal behaviors that elicit health concerns.^{27,30} The model consists of six constructs: perceived susceptibility, severity, benefits and barriers, cues to action, and self-efficacy.³¹ It is theorized that when these perceptions are taken into consideration during program planning, behavioral change is likely to result.²⁷ As an example of how the HBM can be applied, an intervention might include information on populations at risk for the FT (perceived susceptibility), consequences of the FT (perceived severity), positive results and challenges of taking action to reduce risks (perceived benefits and barriers), information on how to select healthy meals containing adequate

Table 1 Nutrition for Optimal Performance: Theoretical Constructs Incorporated Into Program Content

Theoretical Construct	Program Content
Perceived Susceptibility and Severity*	Consequences and risks of the Female Athlete Triad (FT) in terms of health and dancing career Facts on dancers' susceptibility to the FT
Benefits and Barriers*	Eating properly increases health, energy level, and performance
Outcome Expectations of Behavior Changes†	Developing healthy habits is free, while doctor visits, medications, and physical therapy is costly and time consuming
Personal Reinforcement†	Days taken to recover from injury decrease skills, training time, and important performing opportunities. This may be prevented by the development of good eating habits.
Cues to Action*	Still pictures of all food items and meals discussed
Observational Learning†	Still pictures and video clips of adolescent, healthy dancers performing healthy activities Still pictures and video clips of healthy professional dancers
Perceived Self-Efficacy*†	Information to help guide dancers in making healthier dietary choices
Goals†	Skills for making a healthy breakfast, lunch, and dinner Skills for monitoring hydration status Skills to prevent the development of the FT Information on ten healthy habits to include in a daily routine, and how to adopt them

*Health Belief Model, †Social Cognitive Theory.

amounts of energy (cues to action), and a demonstration of basic meal preparation skills (self-efficacy). The SCT revolves around the interplay of behavioral, personal, and environmental factors,³⁰ and core constructs of this theory include knowledge, perceived self-efficacy, outcome expectations, goals, and perceived facilitators and barriers to achieving one's goals.²⁷ An intervention incorporating these constructs may be used to motivate people to adopt new behaviors such as healthier dietary habits.²⁹ As an example, in addition to those previously mentioned, an intervention could include information on how eating well may improve performance (outcome expectations) and healthy habits to aim for (goals).

The overall purpose of the current investigation was to develop, implement, and evaluate the effectiveness of a DVD-based nutrition education intervention, "Nutrition for Optimal Performance," aimed at improving health knowledge and behaviors of adolescent dancers aged 13 to 18 years. This program incorporates constructs of the HBM and SCT, while taking into account the needs and interests of the target population and the culture of professional dance organizations. Specific program objectives are to: 1. inform young dancers of the conditions comprising the FT and increase their awareness of associated health risks; 2. educate dancers on basic sports nutrition principles that promote health and performance; and 3. provide dancers with the skills needed to develop healthy lifestyle habits. Targeted program outcomes include increasing nutrition knowledge, improving self-efficacy for adopting healthy dietary habits, and promoting the consumption of fruits, vegetables, and high-calcium foods while decreasing consumption of nutrient-poor, high-fat and high-sugar foods among adolescent pre-professional ballet dancers (Table 1).

Materials and Methods

Program Development

An overview of the study design is provided in Figure 1. Initial stages of

program development included two preliminary studies, one of which assessed the nutrition knowledge and beliefs of the target population, and a second addressed to program directors that explored the current availability and type of nutrition education offered to professional ballet dancers and adolescent dancers training in professional academies. Preliminary Study One included 39 male and female dancers between the age 9 to 17 years who were participating in a pre-professional summer dance program. An open-ended survey was administered to gauge their interest in, knowledge of, and beliefs regarding nutrition education. Survey questions included: "What would you like to

learn about nutrition and why?" "What do you think would make a nutrition lecture interesting to dancers?" "What do you think happens if you don't eat enough calories, and how do you think it affects your dancing?" "Do you think what you eat and when affects your dancing, and if so, how?" Most dancers (more than 50%) wanted to learn how to "build leaner muscles," and "lose weight and keep weight off." Of those who indicated they desired weight loss, all (100%) recognized that if they did not eat enough calories they would "feel shaky, weak, and tired, yet look skinnier." All (100%) of the survey respondents were interested in learning nutrition principles that would benefit

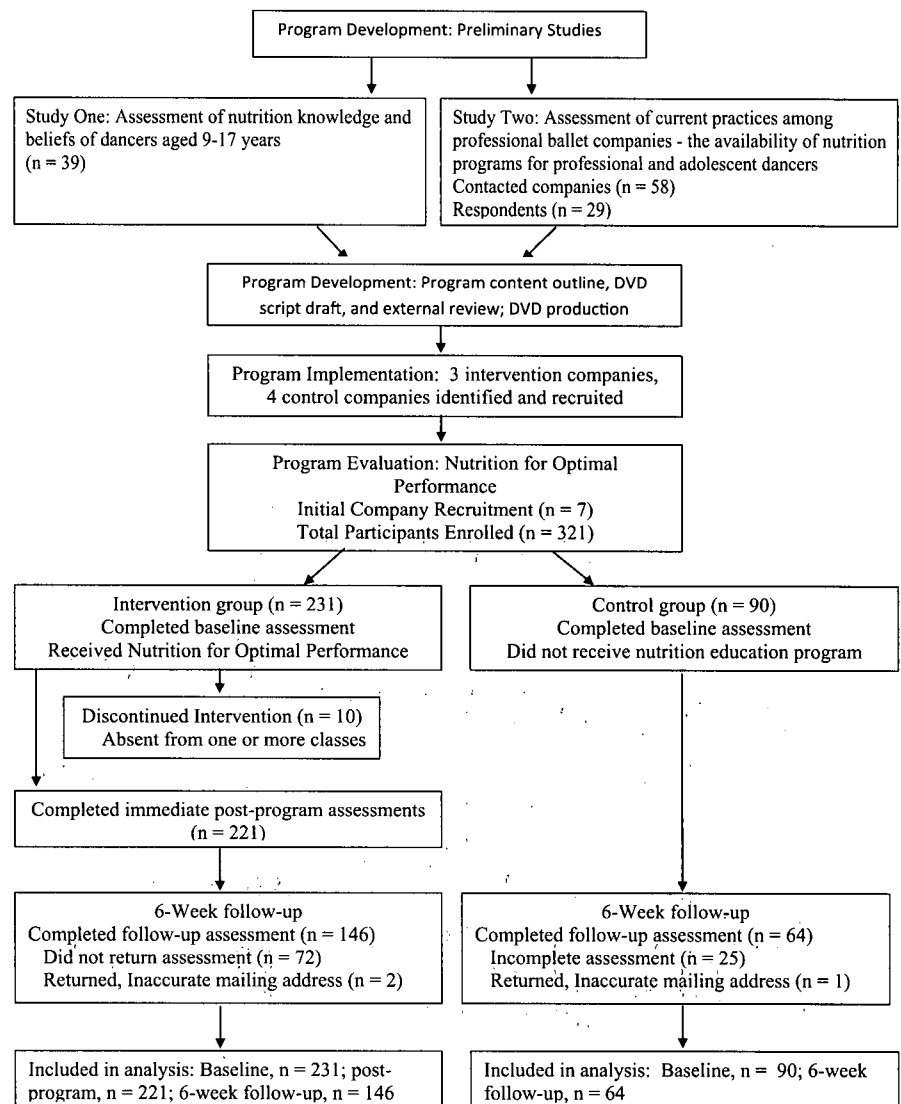


Figure 1 Program development, implementation, and evaluation of "Nutrition for Optimal Performance."

their performance and overall health. These preliminary findings are consistent with prior work demonstrating the need for nutrition education focused on informing young dancers of their nutritional needs and teaching skills for adopting healthier dietary behaviors.¹⁸

The second preliminary study asked such survey questions as: "Do you currently have some type of nutrition education program for your professional dancers (for example, programs that address eating for good health and performance)? If yes, list type of program: e.g., workshops, seminars, or individual counseling with a nutritionist." "Do you currently have some type of nutrition education program for your students attending the academy during the school year?" "If a nutrition program is not offered, what is the primary reason for this?" "What do you believe would be the optimal length of such a program if you were to offer one?" Of 58 national companies identified, 29 company directors (50%) completed the survey. According to this survey, 41% (n = 12) of the companies offer some type of nutrition education to

their professional dancers, often provided through individual counseling, and only when deemed necessary by the artistic director. Many professional ballet companies have competitive pre-professional summer intensive programs: a 3 to 6 week, audition-required "summer camp," where young dancers are often housed in dormitories, eat in cafeterias, and dance six or more hours per day. Of the companies surveyed that offer summer intensive programs, 85% indicated that they provide nutrition education for the adolescent dancers in training. The quality and content of the education, however, appeared variable. For example, the qualifications of program delivery personnel often were not identified, and two companies specifically stated that a former dancer or instructor taught their nutrition classes. Only three of 23 companies indicated that the education was delivered by a health professional (e.g., registered dietitian, physician).

These preliminary studies demonstrated the typical nutrition knowledge, beliefs, and areas of interest of the target population, as well as

the need for a high-quality nutrition education program that could feasibly be made available to pre-professional adolescent dancers. Based on these preliminary findings and the theoretical components of the HBM and SCT, a program content outline and script was developed, entitled "Nutrition for Optimal Performance." The script was revised following external review by two registered dietitians with expertise in sports nutrition and media communications and by a female professional ballet dancer. It was then narrated and recorded in a DVD format and edited to include video clips of professional and adolescent dancers, still photos, and text to accompany the narration. The DVD underwent multiple revisions and was finalized as three 10 to 20 minute segments, a length believed to be optimal given the age of the targeted population.

Topics of the three DVD segments include information on the FT and associated health risks, basic nutrition principles such as sources and functions of macronutrients and micronutrients (vitamin D, vitamin C, calcium, and iron), the impor-

Table 2 Nutrition for Optimal Performance: Class Titles and Objectives

Class Title	Class Objectives
Class One: An Overview: Nutrition for pre-professional dancers and the importance of healthy behaviors (10 Minutes)	Participants will learn: The difference between aerobic and anaerobic exercise; What the Female Athlete Triad is, the three conditions comprising the Triad, and associated risks; The importance of adopting healthy eating habits. Handout: "Healthy Behaviors and the Female Athlete Triad: Being the Best You Can Be!"
Class Two: Nutrition Principles for Dancers (16 Minutes)	Participants will learn: What a calorie is, and how many dancers need to consume in one day for good health; The three primary macronutrients found in food, what they provide the body, how much should be eaten daily and specific food sources of each; The roles of vitamin D, vitamin C, Calcium, and Iron including the recommended daily allowance for adolescent athletes and specific food sources of each. Handout: "Nutrition Principles for Dancers: Learning the Basics" Worksheet: "Application of Nutrition Principles"
Class Three: Eating for Optimal Health and Performance (16 Minutes)	Participants will: Be able to name at least five healthy habits to aim for daily; Understand the importance of drinking water and staying hydrated, and how to monitor their own hydration status ("WUT"); Be able to give an example of a dinner that should be eaten the evening before a performance. Handout: "Eating for Optimal Performance: What Should I Eat?"

tance of adopting healthy behavioral habits for dancers, maintaining and monitoring hydration, and eating for optimal health and performance, with a focus on exemplary meals and snacks (Table 2). Handouts presenting the main objectives of each class as well as “worksheets” to reinforce content related to macronutrient functions, percentages, and food sources, and optimal pre-performance breakfast menus were developed. The study protocol was approved by the Institutional Review Board of Virginia Polytechnic and State University prior to study initiation.

Program Evaluation

Following DVD program development, seven elite professional ballet companies were contacted and expressed willingness to participate in the program evaluation. These companies were sent packets of information containing a cover letter explaining the purpose, potential benefits, and requirements of the study, along with informed consent documents for both parents and participants. The companies mailed this packet to dancers (aged 13 to 18 years old) who had been accepted into their summer intensive program. The signed forms were mailed back to the ballet company along with the company's own summer intensive registration material, and then forwarded to the study investigators.

All dancers enrolled in the three summer intensives of the “intervention” companies ($n = 445$) attended the nutrition classes of the educational program; however, only those who had provided prior consent completed pre- and post-program assessments. Teaching and administrative staff of the ballet companies were encouraged to attend the lectures. The lead investigator (A.D-L.) was present at all three DVD class segments during each summer intensive, and distributed all handouts, worksheets, and assessment forms to the participants. A one-hour time period was allotted for three consecutive days at each company. This allowed time for participants to view the DVD program and complete

worksheets and assessments.

The lead investigator also attended the control group summer intensive programs to administer assessments during one 30-minute time period. These dancers did not receive the nutrition education program, but they were given a packet of printed nutrition information following the completion of their 6-week follow-up assessments. Directors of the control group companies were provided copies of all program materials (DVD lecture series and handouts) following the study, in the event they might wish to include the program in the following year's summer intensive.

Participants

A total of 321 male and female dancers from seven programs affiliated with professional ballet companies were enrolled in this study. The intervention group participants ($n = 231$) received the “Nutrition for Optimal Performance” program, while those in the control group ($n = 90$) did not.

Assessments

Assessment instruments included self-reported general demographic information (name, age, ethnicity, weight, height, body mass index [BMI, calculated from self-reported weight and height], years dancing, previous nutrition education, and contact information), a Sports Nutrition Knowledge and Behavior Questionnaire (SNKBQ), and a Food Frequency Questionnaire (FFQ; sections adapted from previously published tools or developed specifically for this study). As depicted in Figure 1, intervention group participants completed assessments prior to the program, immediately post-program, and at six weeks post-program to determine the long-term effectiveness and sustainability of targeted outcomes. Control group participants were assessed at the beginning of the summer intensive program and again six weeks after returning home. All participants were instructed not to look for answers to SNKBQ items post-program to avoid external influence on the 6-week follow-up scores.

All questionnaires (with completion instructions attached) were administered by the lead investigator, except for the 6-week assessments which were mailed to the participants in a packet including a stamped, addressed return envelope. Participants were given contact information (phone number and e-mail address) for both the lead and co-investigator in case any questions arose. They were compensated in the form of a \$10 gift card, which was mailed to them upon completion of the 6-week assessments.

The SNKBQ was developed for this investigation after reviewing literature on adolescent dancers' health and nutrition misconceptions, and prior work done by this investigative team.¹³ It consists of two sections: one explores sports nutrition knowledge, the other perceived susceptibility to the FT, self-efficacy for adopting and maintaining healthier dietary habits, and outcome expectations for the development of such habits (Table 3). Answers to questions in the second section were scored 1-5, based on the nutrition self-efficacy scale developed by Anderson and coworkers³² and the HBM scale developed by Champion and colleagues.³³ The second section also includes five questions from the Eating Attitudes Test-26³⁴ to assess abnormal eating behaviors (AEB), allowing participants to score a maximum of 15 total points. The SNKBQ was pilot-tested in 15 adolescent dancers to ensure clear and understandable wording of questions and answers and to test reliability. Pilot participants completed the SNKBQ on two occasions, one week apart. The Wilcoxon Signed Rank Test was used to determine reliability (time 1, time 2) for each question. Responses were not different for 20 of 21 knowledge questions. Three of 11 behavior question responses differed significantly, but in a direction that suggested that repeated test administration may have influenced responses. Overall SNKBQ scores (percent correct) were not different (time 1: $64 \pm 5\%$; time 2: $64 \pm 4\%$; $p = 0.87$).

The FFQ consisted of questions from previously validated question-

Table 3 Sports Nutrition Knowledge and Behavior Questionnaire, Part Two: Response Options and Associated Question Stems

Section One: Female Athlete Triad Perceived Severity (2 questions)	
Response Options	Questions
Scale: 1-Strongly Disagree to 5-Strongly Agree Total Score: 10 Maximum	1. I believe that the Female Athlete Triad is a severe health problem affecting dancers. 2. If I had the Female Athlete Triad my dancing would suffer.
Section Two: Healthy Habits Perceived Self-Efficacy (4 questions)	
Scale: 1-Not Certain to 5-Very Certain Total Score: 20 Maximum	3. How certain are you that you would know what foods to choose for a healthy breakfast meal? 4. I am certain that I know how to consume enough calcium through food sources every day. 5. How likely are you to bring fruit to the studio/theatre and eat it for a snack between rehearsals every day? 6. How likely are you to consume a carbohydrate-rich dinner the evening prior to a performance?
Section Three: Abnormal Eating Behaviors (5 questions selected from EAT-26*)	
Responses: Always, Usually, Often, Sometimes, Rarely, or Never Total Score: Maximum 15	7. I avoid eating when I am hungry. 8. I am aware of the calorie content of foods that I eat. 9. I particularly avoid foods with a high carbohydrate content (i.e., bread, rice, potatoes, etc.). 10. I feel extremely guilty after eating. 11. I avoid foods with sugar in them.

*EAT-26, Eating Attitudes Test-26.

naires, including the Block dietary fat and fruit-vegetable-fiber screener³⁵ and selected questions adapted from the Youth Risk Behavior Survey³⁶ and Youth/Adolescent Food Frequency Questionnaire.^{37,38} The FFQ assesses intake by adolescents of food groups including fruits, juices, water, vegetables, cereals, protein sources, milk and cheese, soft drinks, sweets, and high fat snacks, with outcomes measured in servings and frequency.³⁵

Statistical Analysis

Data analyses (SPSS for Windows, V.12.0.) included descriptive characteristics, independent sample t-tests for between group comparisons (demographic characteristics and baseline primary outcomes), and chi-square tests for frequency variables. One-way ANOVA with Tukey post-hoc tests and repeated measures ANOVA were used for between-company comparisons and to determine differences over the three time points among intervention group participants. Where differences over time were found, paired t-tests were used to identify significant differences between time points. Power calculations on the

key outcome variable of the SNKBQ score, using results from literature on nutrition intervention programs (expected within group differences, standard deviations, $\alpha = 0.05$) indicated that within group statistical power was 99% for SNKBQ scores with a sample size of 115 per group. Because results are dependent on the number of returned 6-week follow-up assessments, power calculations were also performed on a within group sample size of 75 subjects, which estimated a 65% return rate of follow-up assessments. With a sample size of 75 per group, statistical power was 98% for SNKBQ scores.

Results

Participants in the summer intensive training programs of six professional companies and one youth professional company were recruited for this study. Three of these companies (I1, I2, I3) comprised the intervention group, and four companies (C4, C5, C6, C7) the control group. Self-reported baseline demographic characteristics of intervention and control companies are presented in Table 4. Baseline primary outcomes, including sports

nutrition knowledge and eating behaviors, were similar within groups. Differences within control companies were found in age (C5) and years dancing (C6). Differences within the intervention companies were found in age and height (I3) and in BMI (I1). Although these differences were observed in some self-reported demographic characteristics, their magnitude (at most less than 1 unit) is not believed to be of practical significance. Since demographic characteristic differences across company type were minimal, baseline primary outcomes were not different, and all participating companies were of comparable caliber and reputation, the companies were collapsed into two groups, "Intervention" and "Control" (Table 5). The intervention group consisted of 231 participants. Of these, 221 completed both baseline and immediate post-program assessments, and 146 completed all three assessments (a 63% completion rate). The control group consisted of 90 participants, 64 of whom completed both baseline and 6-week follow up assessments (a 71% completion rate). At baseline, primary outcomes of sports nutrition

Table 4 Comparison of Baseline Demographic Characteristics of Intervention (I) and Control (C) Companies (Means $\pm$ SEM)

	I 1 (n = 60)	I 2 (n = 91)	I 3 (n = 80)	C 4 (n = 28)	C 5 (n = 16)	C 6 (n = 23)	C 7 (n = 23)
SNKBQ, (percent correct)	65.3 $\pm$ 2.0	64.2 $\pm$ 1.5	66.4 $\pm$ 1.6	66.3 $\pm$ 3.0	64.3 $\pm$ 2.2	60.4 $\pm$ 3.3	60.2 $\pm$ 2.0
AEB score	1.2 $\pm$ 0.2	1.6 $\pm$ 0.2	1.9 $\pm$ 0.2	1.4 $\pm$ 0.3	1.5 $\pm$ 0.5	1.3 $\pm$ 0.3	1.5 $\pm$ 0.3
Age (years)	15.2 $\pm$ 0.2 ^a	15.1 $\pm$ 0.1 ^a	15.9 $\pm$ 0.1 ^b	15.6 $\pm$ 0.3 ^{ab}	16.4 $\pm$ 0.2 ^b	15.0 $\pm$ 0.3 ^a	15.0 $\pm$ 0.3 ^a
Weight (kg)	51.7 $\pm$ 1.0	50.0 $\pm$ 0.8	51.6 $\pm$ 0.7	51.7 $\pm$ 1.3	53.7 $\pm$ 2.2	51.3 $\pm$ 1.3	53.0 $\pm$ 1.5
Height (cm)	165 $\pm$ 1.1 ^a	165 $\pm$ 0.8 ^{ab}	168 $\pm$ 0.7 ^b	164 $\pm$ 1.4	165 $\pm$ 2.3	163 $\pm$ 1.3	166 $\pm$ 1.5
BMI (kg/m ²)	18.9 $\pm$ 0.2 ^b	18.2 $\pm$ 0.2 ^a	18.2 $\pm$ 0.1 ^a	19.1 $\pm$ 0.3	19.6 $\pm$ 0.4	19.3 $\pm$ 0.4	19.3 $\pm$ 0.4
Years Dancing	9.2 $\pm$ 0.3	9.3 $\pm$ 0.3	10.0 $\pm$ 0.3	10.2 $\pm$ 0.5 ^{ab}	10.9 $\pm$ 0.7 ^{ab}	11.1 $\pm$ 0.4 ^b	8.9 $\pm$ 0.5 ^a

BMI, Body Mass Index; SNKBQ, Sports Nutrition Knowledge and Behavior Questionnaire; AEB, Abnormal Eating Behaviors (score out of 15). ^{a,b}Different letters indicate significant mean differences ($p \leq 0.05$) within each company type (I, C) using a Tukey post hoc analysis.

knowledge and eating behavior scores were similar between groups (Table 5). No differences in baseline group demographic characteristics were noted, with the exception of BMI and years dancing, and these differences were minimal (less than 1 BMI unit, less than 1 year of dancing experience). To account for these variables at baseline, they were included as covariates in subsequent analyses.

Group differences in results suggest that the intervention program was effective in increasing nutrition knowledge, perceived severity, and self-efficacy (Table 6). SNKBQ scores from baseline to follow-up in the intervention group increased by 25%, yet only by 8% within the control

group. Perceived severity and self-efficacy scores also increased greatly over time in the intervention group relative to the control group (perceived severity score: intervention group $\Delta = 1.0$, control group $\Delta = 0.1$; self-efficacy score: intervention group $\Delta = 1.9$, control group $\Delta = 0.6$). No changes were detected in AEB scores in either group. Reported dietary fat, saturated fat, and diet soda intake decreased significantly over time in both groups, while milk intake significantly increased within the intervention group ($> 7\%$). Candy intake significantly declined (by 33%) among intervention group participants, as compared to 11% in the control group.

Significant improvements were ob-

served in the intervention group from baseline to immediate post-program assessments in nutrition knowledge (baseline: 66 ± 1 vs. post-program: 93 ± 1 % correct, $p \leq 0.05$), perceived self-efficacy (7.7 ± 0.1 vs. 8.9 ± 0.1 score, $p \leq 0.05$) and perceived severity (15.5 ± 0.2 vs. 17.9 ± 0.2 score, $p \leq 0.05$) (Table 7). Although these scores declined from post-program to the 6-week follow-up assessment, they remained significantly improved from baseline. Reported AEB scores increased for most program participants over the three assessment periods. To further determine how the program influenced abnormal eating behaviors, analysis was conducted on participants ($n = 30$) who scored above

Table 5 Baseline Demographic Characteristics of Enrolled Participants

	Intervention (n = 231) Mean $\pm$ SEM (Range)	Controls (n = 90) Mean $\pm$ SEM (Range)
SNKBQ, % correct	65.2 $\pm$ 1.0 (24.0 - 90.0)	62.9 $\pm$ 1.4 (29.0 - 95.0)
AEB, Score	1.6 $\pm$ 0.1 (0.0 - 12.0)	1.4 $\pm$ 0.2 (0.0 - 6.0)
Age (years)	15.4 $\pm$ 0.1 (13.0 - 18.0)	15.4 $\pm$ 0.1 (13.0 - 18.0)
Weight (kg)	51.0 $\pm$ 0.5 (34.1 - 74.1)	52.3 $\pm$ 0.7 (34.8 - 74.0)
Height (cm)	166 $\pm$ 0.5 (145 - 188)	164 $\pm$ 0.8 (150 - 185)
BMI (kg/m ²)	18.4 $\pm$ 0.1 (15.0 - 22.9)	19.3 $\pm$ 0.2* (15.5 - 23.5)
Years Dancing	9.5 $\pm$ 0.2 (3.0 - 15.0)	10.2 $\pm$ 0.3* (2.0 - 15.0)
Sex	14 Male, 217 Female	6 Male, 84 Female
Previous Sports Nutrition Counseling Received	173 Yes, 58 No	58 Yes, 32 No

*Significantly different from Intervention participants ($p \leq 0.05$). BMI, Body Mass Index; SNKBQ, Sports Nutrition Knowledge and Behavior Questionnaire; AEB, Abnormal Eating Behaviors (score out of 15).

Table 6 Baseline and 6-Week Follow-Up Assessment Results for Intervention and Control Participants for Nutrition Knowledge, Theory-Based Behavioral Constructs and Self-Reported Dietary Intake (Mean $\pm$ SEM)

Baseline Demographic Characteristics	Intervention Group (n = 146)		Control Group (n = 64)	
Age (years)	15.4 $\pm$ 0.1		15.4 $\pm$ 0.2	
BMI (kg/m ²)	18.3 $\pm$ 0.1		19.3 $\pm$ 0.2*	
Years Dancing	9.5 $\pm$ 0.2		10.1 $\pm$ 0.3	
Nutrition Knowledge and Related Behavioral Constructs:	Baseline	6-week follow-up	Baseline	6-week follow-up
SNKBQ, †† (percent correct)	66.5 $\pm$ 1.2	91.0 $\pm$ 1.0	62.7 $\pm$ 1.8	70.9 $\pm$ 1.5
FT Perceived Severity, ‡ Total Score (Maximum 10)	7.7 $\pm$ 0.1	8.7 $\pm$ 0.1	7.6 $\pm$ 0.2	7.7 $\pm$ 0.2
HH Perceived Self-Efficacy, ‡ Total Score (Maximum 20)	15.5 $\pm$ 0.2	17.4 $\pm$ 0.2	15.4 $\pm$ 0.4	16.0 $\pm$ 0.3
AEB, Score (Maximum 15)	1.5 $\pm$ 0.2	1.8 $\pm$ 0.2	1.5 $\pm$ 0.2	1.4 $\pm$ 0.3
Self-Reported Dietary Intake:				
Total Fat† (grams)	95.2 $\pm$ 1.8	88.2 $\pm$ 1.6	91.7 $\pm$ 2.8	89.3 $\pm$ 2.5
Saturated Fat† (grams)	25.1 $\pm$ 0.7	22.5 $\pm$ 0.6	23.1 $\pm$ 1.1	22.2 $\pm$ 1.0
Percent Fat†	34.9 $\pm$ 0.5	33.2 $\pm$ 0.4	34.0 $\pm$ 0.7	33.4 $\pm$ 0.6
Fruit and Vegetable (servings)	4.9 $\pm$ 0.1	4.5 $\pm$ 0.1	4.9 $\pm$ 0.2	4.4 $\pm$ 0.2
Vitamin C (mg)	162 $\pm$ 3	155 $\pm$ 4	164 $\pm$ 5	151 $\pm$ 6
Magnesium (mg)	400 $\pm$ 6	387 $\pm$ 7	399 $\pm$ 9	377 $\pm$ 10
Potassium (mg)	3803 $\pm$ 58	3681 $\pm$ 65	3813 $\pm$ 90	3595 $\pm$ 100
Fiber (grams)	21.3 $\pm$ 0.4	20.5 $\pm$ 0.4	21.4 $\pm$ 0.6	20.0 $\pm$ 0.7
Low Fat Dairy Score ^a	2.4 $\pm$ 0.1	2.2 $\pm$ 0.1	2.3 $\pm$ 0.1	2.1 $\pm$ 0.2
Fried Fast Food Score ^a	0.5 $\pm$ 0.1	0.4 $\pm$ 0.1	0.6 $\pm$ 0.1	0.7 $\pm$ 0.1
Candy‡ Score ^a	1.2 $\pm$ 0.1	0.8 $\pm$ 0.1	0.9 $\pm$ 0.1	0.8 $\pm$ 0.1
Milk†‡ Score ^b	2.5 $\pm$ 0.1	2.7 $\pm$ 0.1	2.5 $\pm$ 0.2	2.4 $\pm$ 0.2
Soda Score ^b	0.6 $\pm$ 0.1	0.5 $\pm$ 0.1	0.4 $\pm$ 0.1	0.4 $\pm$ 0.1
Diet Soda† Score ^b	0.6 $\pm$ 0.1	0.5 $\pm$ 0.1	0.3 $\pm$ 0.1	0.3 $\pm$ 0.1
Water Score ^b	5.1 $\pm$ 0.1	5.0 $\pm$ 0.1	5.0 $\pm$ 0.2	4.5 $\pm$ 0.2

SNKBQ, Sports Nutrition Knowledge and Behavior Questionnaire; FT, Female Athlete Triad; HH, Healthy Habits; AEB, Abnormal Eating Behaviors. *Significantly different from Intervention participants ($p \leq 0.05$). †Significant main effect of time, $p \leq 0.05$. ‡Significant group by time interaction, $p \leq 0.05$. ^aScore: 0, never/less than 1 serving per week; 1, 1 serving during the past week; 2, 2-6 servings during the past week; 3, 1 serving per day; 4, 2+ servings per day. ^bScore: 0, none during the past week; 1, 1-3 times during the past week; 2, 4-6 times during the past week; 3, 1 time per day; 4, 2 times per day; 5, 3 times per day; 6, 4+ times per day.

the mean AEB (score > 2.0) at baseline. Among those participants, AEB scores decreased from baseline to post-program and remained unchanged in follow-up assessment results (baseline: 4.5 $\pm$ 0.4; post-program: 4.0 $\pm$ 0.4; 6-week follow-up: 4.0 $\pm$ 0.5).

Across the three time points, improvements were observed in dietary

intake from baseline to post-program (Table 7). Total fat ($\Delta = -6.4$ g), saturated fat ($\Delta = -2.4$ g), percent fat ($\Delta = -1.7\%$) and candy intake (from > 1 serving/wk to < 1 serving/wk) decreased from baseline through follow-up assessments. Significant decreases were observed in fruit and vegetable consumption from

post-program to 6-week follow-up; however, improvements in fast food intake (20% reduction) and milk consumption (11% increase) were also reported. Lastly, water intake significantly increased from baseline to immediate post-program, with participants consuming water three times per day to almost four times per

Table 7 Intervention Group Results of Participants Completing All Baseline, Immediate Post-Program, and 6-Week Follow-Up Assessments (n = 146) (Mean ± SEM)

Nutrition Knowledge and Related Behavioral Constructs:	Baseline	Post-Program	6-Week Follow-Up
SNKBQ, (percent correct)	66.4 ± 1.2	93.4 ± 0.8*	91.0 ± 0.8*†
FT Perceived Severity, Total Score (Maximum 10)	7.7 ± 0.1	8.9 ± 0.1*	8.7 ± 0.1*
HH Perceived Self-Efficacy, Total Score (Maximum 20)	15.5 ± 0.2	17.9 ± 0.2*	17.4 ± 0.2*†
AEB, Score (Maximum 15)	1.5 ± 0.2	1.5 ± 0.2	1.8 ± 0.2*†
Self-Reported Dietary Intake:	Baseline	Post-Program	6-Week Follow-Up
Total Fat (g)	95.0 ± 1.8	93.0 ± 1.7*	88.6 ± 1.6*†
Total Saturated Fat (g)	25.0 ± 0.7	24.1 ± 0.7*	22.6 ± 0.6*†
Percent Fat (percent)	35.0 ± 0.4	34.3 ± 0.4*	33.3 ± 0.4*†
Fruit and Vegetables (servings)	4.9 ± 0.1	4.8 ± 0.1	4.5 ± 0.1*†
Vitamin C (mg)	161 ± 3	164 ± 3	155 ± 4†
Magnesium (mg)	398 ± 6	402 ± 6	387 ± 7†
Potassium (mg)	3795 ± 58	3834 ± 58	3678 ± 65†
Fiber (grams)	21.2 ± 0.4	21.5 ± 0.4	20.5 ± 0.4†
Low Fat Dairy ^a Score	2.3 ± 0.1	2.5 ± 0.1	2.2 ± 0.1†
Fried Fast Food ^a Score	0.5 ± 0.1	0.4 ± 0.1*	0.4 ± 0.1*
Candy ^a Score	1.2 ± 0.1	1.0 ± 0.1*	0.8 ± 0.1*†
Milk ^b Score	2.4 ± 0.1	2.5 ± 0.1	2.7 ± 0.1*†
Soda ^b Score	0.6 ± 0.1	0.5 ± 0.1	0.5 ± 0.1
Diet Soda ^b Score	0.6 ± 0.1	0.5 ± 0.1	0.5 ± 0.1
Water ^b Score	5.1 ± 0.1	5.4 ± 0.1*	5.0 ± 0.1†

SNKBQ, Sports Nutrition Knowledge and Behavior Questionnaire; FT, Female Athlete Triad; HH, Healthy Habits; AEB, Abnormal Eating Behaviors. *Significantly different from baseline scores, $p \leq 0.05$. †Significantly different from post-program scores, $p \leq 0.05$. ^aScore: 0, never/less than 1 serving per week; 1, 1 serving during the past week; 2, 2-6 servings during the past week; 3, 1 serving per day; 4, 2+ servings per day. ^bScore: 0, none during the past week; 1, 1-3 times during the past week; 2, 4-6 times during the past week; 3, 1 time per day; 4, 2 times per day; 5, 3 times per day; 6, 4+ times per day.

day, yet declined to baseline levels by the 6-week follow-up assessment.

Discussion

These findings demonstrate that the "Nutrition for Optimal Performance" intervention program significantly improved nutrition knowledge, perceived severity of the FT, and self-efficacy for adopting healthier dietary habits in pre-professional adolescent ballet dancers. Furthermore, these changes were sustained for at least six weeks following program participation; although some 6-week follow-up scores decreased from post-program scores in the intervention group, they remained significantly improved from both baseline and the control group's 6-week follow-up scores. The program was also associated with improving

self-reported dietary intake habits, such as reduced candy, fast food, and soda consumption and increased milk consumption.

The lack of improvement in other dietary variables could be attributed to several factors. First, the tools used in the assessments of dietary intake may not have been adequate to detect the changes in all dietary intake variables. Second, participants completed the follow-up assessment in a different environment than baseline and 6-week assessments (i.e., eating away from home in a cafeteria setting and making their own dietary choices versus the home environment). Thus, future interventions could include outreach to families.

Lastly, because some dietary improvements were observed in post-

program but not in 6-week follow-up assessments, this may indicate the possibility of limited, short-term program effectiveness. Improvements in nutrition knowledge and perceptions may be immediately detectable, whereas changes in nutrient consumption may be more gradual and therefore less apparent in short (e.g., 6-week) follow-up periods.²⁰ Thus, future studies might include longer follow-up.

A selection of questions from the EAT-26 was chosen to help identify abnormal eating behaviors (Table 3), but not to diagnose disordered eating. Overall, AEB scores were very low (< 2 of 15-point maximum). Also, there were no group by time differences in AEB scores; the only significant increase in score was noted in the intervention group at the 6-week

follow-up. Importantly, a reduction in scores in the population subset of the intervention group who scored above the mean at baseline was observed in the immediate post-program AEB scores. Also, 6-week follow-up scores for these intervention participants remained the same as immediate post-program results. Program content included discussion of the calorie content of food items to educate dancers about, for example, macronutrient composition of food items. This information may have increased the dancers' awareness of the caloric content of specific foods, causing them to answer AEB questions (e.g., question 8 in Table 3) differently post-program, in which case this would not necessarily indicate problems with abnormal eating behaviors. This program did not directly address eating disorders; the objective was to educate adolescent dancers in skills for making healthy dietary choices. The overall increase in intervention group AEB scores may, therefore, be the result of increased nutrition awareness. Future studies may consider including more comprehensive assessments of abnormal eating behaviors.

At baseline, less than 40% of study participants were able to accurately answer questions on the SNKBQ related to the FT, and knowledge was poor (less than 40% answered correctly) in areas concerning the functions and food sources of macronutrients and vitamins (e.g., vitamins C and D). These findings indicate that future nutrition education intervention programs should include information addressing these specific topics.

The implementation of the program in several companies during summer intensives serves as a strength of this investigation. Companies may vary in bias toward ideals of body image and eating habits; thus, demonstrating effectiveness in a large sample including multiple companies increases the generalizability of our findings. Also, the DVD-format of the program promotes ease of program delivery and reproducibility while minimizing cost. Lastly, the large sample size and relatively high follow-up response rate

(68%) were strengths.

Nevertheless, we acknowledge several limitations. First, the program was of short duration (however, a similar intervention of longer duration—12 weekly two-hour classes—reported similar findings of increased nutrition knowledge yet no difference in nutrient intake from baseline to post-intervention to 6-month follow-up).²⁰ Second, as the AEB portion of the SNKBQ includes only five questions selected from the EAT-26, the conclusions regarding participants' abnormal eating behaviors may be inaccurate. A complete assessment of abnormal and disordered eating behaviors among this population is needed. Future studies should include more comprehensive analyses of dietary intake, eating disorders, and health behavior changes. And lastly, reliance on self-reported measures is a limitation. However, due to the large study sample size, available resources, and limited time for program evaluation, other means of assessing outcomes were not feasible.

Conclusion

Ballet dancers are a high-risk subpopulation of athletes susceptible to adverse health outcomes such as the Female Athlete Triad. Educating adolescent dancers in proper nutrition and improving skills for adopting healthier dietary habits may be one key to preventing the development of such conditions; however, current education promoting the dietary health of dancers is limited. This intervention program increased adolescent dancers' nutrition knowledge and self-efficacy while improving several key dietary intake behaviors. To date, no other intervention aimed at educating adolescent dancers in nutrition and health has been conducted; thus, these findings are novel and have important implications for the field of dance medicine and the profession of dance.

Future interventions promoting adolescent dancers' health should consider including artistic directors, ballet instructors, and families in long-term educational programs, as the influence of these individuals on adolescent

dancers' dietary behaviors and body image perceptions is considerable. In addition, future studies could include an assessment of food items available in the cafeterias of summer intensives as well as snack options accessible to students. Future interventions might also consider incorporating interactive activities such as cooking classes, food preparation demonstrations, and outings to grocery stores to further promote dietary changes. Proper nutrition and eating habits are essential to the health and success of the dancer-athlete and should be incorporated into the training regimens of all pre-professional adolescent dancers.

References

1. Benson JE, Geiger CJ, Eiserman PA, et al. Relationship between nutrient intake, body mass index, menstrual function, and ballet injury. *J Am Diet Assoc.* 1989;89(1):58-63.
2. Cassill K. The bane of the ballerina. Life-threatening thinness. *Sci Dig.* 1980;87:52-5.
3. Micheli LJ, Gillespie WJ, Walaszek A. Physiologic profiles of female professional ballerinas. *Clin Sports Med.* 1984;3(1):199-209.
4. Abraham S. Eating and weight controlling behaviours of young ballet dancers. *Psychopathology.* 1996;29(4):218-22.
5. Kaufman BA, Warren MP, Dominguez JE. Bone Density and amenorrhea in ballet dancers are related to a decreased resting metabolic rate and lower leptin levels. *J Clin Endocrinol Metab.* 2002;87(6):2777-83.
6. Benson J, Gillien DM, Bourdet K, et al. Inadequate nutrition and chronic calorie restriction in adolescent ballerinas. *Phys Sportsmed.* 1985;13(10):79-90.
7. Bonbright JM. The nutritional status of female ballet dancers 15-18 years of age. *Dance Research Journal.* 1989;21(2):9-14.
8. Dahlstrom M, Jansson E, Nordevang E, et al. Discrepancy between estimated energy intake and requirement in female dancers. *Clin Physiol.* 1990;10(1):11-25.
9. Calabrese LH, Kirkendall DT, Floyd M. Menstrual abnormalities, nutritional patterns and body composition in female classical ballet dancers. *Phys Sportsmed.* 1983;11:86-98.

10. Manore MM. Nutritional needs of the female athlete. *Clin Sports Med.* 1999;18(3):549-63.
11. Thompson JL. Energy balance in young athletes. *Int J Sport Nutr.* 1998;8(2):160-74.
12. Nattiv A, Loucks AB, Manore MM, et al. The female athlete triad. *Med Sci Sports Exerc.* 2007;39(10):1867-82.
13. Doyle-Lucas AD, Akers JD, Davy BM. Energetic efficiency, menstrual irregularity, and bone mineral density in elite professional female ballet dancers. *J Dance Med Sci.* 2010;14(4):146-54.
14. Brownell KD, Steen SN, Wilmore JH. Weight regulation practices in athletes: analysis of metabolic and health effects. *Med Sci Sports Exerc.* 1987;19(6):546-56.
15. Sawyer-Morse MK, Smolik T, Mobley C, et al. Nutrition beliefs, practices, and perceptions of young dancers. *J Adolesc Health Care.* 1989;10(3):200-2.
16. Maloney MJ. Anorexia nervosa and bulimia in dancers. Accurate diagnosis and treatment planning. *Clin Sports Med.* 1983;2(3):549-55.
17. McCormick C. Development and Prevention of Disordered Eating in Young Dancers. *SCAN'S PULSE.* 2006;25(1):15-6.
18. Braisted JR, Mellin L, Gong EJ, et al. The adolescent ballet dancer. Nutritional practices and characteristics associated with anorexia nervosa. *J Adolesc Health Care.* 1985;6(5):365-71.
19. Calabrese LH, Kirkendall DT. Nutritional and medical considerations in dancers. *Clin Sports Med.* 1983;2(3):539-48.
20. Yannakoulia M, Sitara M, Matalas AL. Reported eating behavior and attitudes improvement after a nutrition intervention program in a group of young female dancers. *Int J Sport Nutr Exerc Metab.* 2002;12(1):24-32.
21. Chapman P, Toma RB, Tuveson RV, Jacob M. Nutrition knowledge among adolescent high school female athletes. *Adolescence.* 1997;32(126):437-46.
22. Story M, Resnick M. Adolescents' views on food and nutrition. *J Nutr Educ.* 1986;18(4):188-192.
23. Perron M, Endres J. Knowledge, attitudes, and dietary practices of female athletes. *J Am Diet Assoc.* 1985;85(5):573-6.
24. Reading KJ, McCargar LJ, Marriage BJ. Adolescent and young adult male hockey players: nutrition knowledge and education. *Can J Diet Pract Res.* 1999;60(3):166-9.
25. Elliot DL, Goldberg L, Moe EL, et al. Preventing substance use and disordered eating: initial outcomes of the ATHENA (athletes targeting healthy exercise and nutrition alternatives) program. *Arch Pediatr Adolesc Med.* 2004;158(11):1043-9.
26. Stensland SH, Sobal J. Dietary practices of ballet, jazz, and modern dancers. *J Am Diet Assoc.* 1992;92(3):319-24.
27. National Cancer Institute. *Theory at a Glance: A Guide for Health Promotion Practice.* Washington, DC: U.S. Department of Health and Human Services, 2003.
28. Janz NK, Becker MH. The Health Belief Model: a decade later. *Health Educ Q.* 1984;11(1):1-47.
29. Bandura A. Health promotion by social cognitive means. *Health Educ Behav.* 2004;31(2):143-64.
30. Hayden J. *Introduction to Health Behavior Theory.* Boston: Jones and Bartlett, 2008.
31. Edberg M. *Essentials of Health Behavior: Social and Behavioral Theory in Public Health.* Salsbury: Jones and Bartlett, 2007.
32. Anderson ES, Winett RA, Wojcik JR. Social-cognitive determinants of nutrition behavior among supermarket food shoppers: a structural equation analysis. *Health Psychol.* 2000;19(5):479-86.
33. Champion VL. Instrument development for health belief model constructs. *ANS Adv Nurs Sci.* 1984;6(3):73-85.
34. Garner DM, Olmsted MP, Bohr Y, et al. The eating attitudes test: psychometric features and clinical correlates. *Psychol Med.* 1982;12:871-8.
35. Block G, Gillespie C, Rosenbaum EH, et al. A rapid food screener to assess fat and fruit and vegetable intake. *Am J Prev Med.* 2000;18(4):284-8.
36. Center for Disease Control. Methodology of the Youth Risk Behavior Surveillance System. 2004;1-13. Available at <http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5312a1.htm>.
37. Rockett HR, Breitenbach M, Frazier AL, et al. Validation of a youth/adolescent food frequency questionnaire. *Prev Med.* 1997;26(6):808-16.
38. Rockett HR, Wolf AM, Colditz GA. Development and reproducibility of a food frequency questionnaire to assess diets of older children and adolescents. *J Am Diet Assoc.* 1995;95(3):336-40.

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