2011-05-24

Health Knowledge & Health Behavior Outcomes in Adolescents with Elevated Blood Pressure

Stephanie L. Fitzpatrick
University of Miami, fitzpatrickorama@gmail.com

UNIVERSITY OF MIAMI

HEALTH KNOWLEDGE & HEALTH BEHAVIOR OUTCOMES IN ADOLESCENTS WITH ELEVATED BLOOD PRESSURE

By

Stephanie L. Fitzpatrick

A DISSERTATION

Submitted to the Faculty
of the University of Miami
in partial fulfillment of the requirements for
the degree of Doctor of Philosophy

Coral Gables, Florida

June 2011

UNIVERSITY OF MIAMI

A dissertation submitted in partial fulfillment of
the requirements for the degree of
Doctor of Philosophy

HEALTH KNOWLEDGE & HEALTH BEHAVIOR OUTCOMES
IN ADOLESCENTS WITH ELEVATED BLOOD PRESSURE

Stephanie L. Fitzpatrick

Approved:

Patrice G. Saab, Ph.D. Associate Professor of Psychology	Terri A. Scandura, Ph.D. Dean of the Graduate School
Judith R. McCalla, Ph.D. Research Assistant Professor of Psychology	Maria M. Llabre, Ph.D. Professor of Psychology
Neil Schneiderman, Ph.D. Professor of Psychology	Randall Penfield, Ph.D. Professor of Educational and Psychological Studies

FITZPATRICK, STEPHANIE L. (Ph.D., Psychology)
Health Knowledge and Health Behavior Outcomes (June 2011)
in Adolescents with Elevated Blood Pressure

Abstract of a dissertation at the University of Miami.

Dissertation supervised by Associate Professor Patrice G. Saab.
No. of pages in text. (86)

The purpose of this current study was to examine the influence of cardiovascular health knowledge on dietary and physical activity changes in 15-17 year olds with elevated blood pressure. The sample consisted of 167 adolescents randomized into one of three treatment conditions (minimal, moderate, or intense). Each adolescent completed a fitness test (peak VO_2), 24-hour dietary recall, 7 Day Activity Recall (kilocalories expended per day), Self-efficacy Questionnaire, and Stages of Change Questionnaire every three months. The Health Knowledge Assessment was given at baseline and at post-intervention. Classical test theory, confirmatory factor analysis, and item response theory frameworks were applied to examine psychometric properties of the Health Knowledge Assessment. Structural equation modeling was used to examine the change in health behaviors and the relationship with health knowledge, self-efficacy, and readiness for change.

The 34-item Health Knowledge Assessment had good internal consistency and the items loaded onto a single factor at pretest and posttest. Furthermore, there was a good distribution of easy, moderate, and hard items at pretest, but additional hard items were needed at posttest. There were no treatment condition differences in level of health knowledge at pretest. The intense condition had significantly higher health knowledge

than the minimal and moderate conditions at posttest; level of health knowledge for the moderate condition was significantly higher than the minimal condition at posttest. Level of nutrition knowledge at posttest was not associated with any of the dietary intake variables nor was level of exercise knowledge associated with the two physical activity variables at post-intervention. However, there was a marginally significant association between level of nutrition knowledge and nutrition self-efficacy at posttest. Nutrition self-efficacy and nutrition readiness for change at posttest were also associated with a decrease in sugar consumption at post-intervention.

Implications of this study suggest that a cardiovascular health intervention for adolescents with elevated blood pressure, consisting of group sessions and/or individual sessions over the course of three to six months, was effective in terms of increasing cardiovascular health knowledge, self-efficacy, and readiness for change. Nonetheless, the role that health knowledge plays in health behavior change needs to be further examined.

DEDICATION

This dissertation is dedicated to my mentors, dear friends, and family members who have left an imprint on my life throughout this journey. To my grandparents, Annie Lou (Nan Nan), Doris Mae, and Sonny, thank you for teaching me the importance of getting an education. For Jeffrey, Jazmyn, and Jerykah, always aim high. To Mom, Dad, Shun, and Jeff, thank you for your love and support. To God be the Glory!

ACKNOWLEDGEMENTS

I would like to thank Drs. Patrice Saab, Judy McCalla, and Maria Llabre, for their guidance and support throughout my doctoral studies.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1: Literature Review

The prevalence of cardiovascular disease (CVD) risk factors among youth living in the United States is on the rise. According to NHANES data, 1988-2002, the prevalence of high blood pressure (i.e., systolic and/or diastolic blood pressure ≥ 95^{th} percentile) among children and adolescents increased from 2.7% to 3.7% (Din-Dzietham, Liu, Bielo, & Shamsa, 2007). Furthermore, during 1999-2004 the percentage of overweight 12-19 year olds went from 14.8% to 17.4% (Ogden, Carroll, Curtin, McDowell, Tabak, et al., 2006). Recent research suggests that elevated blood pressure and being overweight is often comorbid in adolescents (McNiece, Poffenbarger, Turner, Franco, Sorof et al., 2007; Torrance, McGuire, Lewanczuk, & McGavock, 2007) and the combination increases risks for hyperlipidemia (Kanani & Sperling, 2002) and the development of atherosclerosis (Orio, Palomba, Cascella, Savastano, Lombardi et al., 2007). Research also suggests a relationship between cardiovascular disease manifested in adulthood and adolescent diet (Mikkila, Rasanen, Raitakari, Marniemi, Pietinen et al., 2007) as well as dietary intake and childhood obesity (Moreno & Rodriguez, 2007). High levels of sedentary behavior such as watching television, playing video games, or using the computer has been associated with poor cardiorespiratory fitness (Pate, Wang, Dowda, Farrell, & O'Neil, 2006), increased meal snacking, and less engagement in regular physical activity (Crespo, Smit, Troiano, Bartlett, Macera et al., 2001). The combination of a sedentary lifestyle and poor eating habits contribute to being overweight/obese and having elevated blood pressure, which further increases risk for CVD (Ernst & Obarzanek, 1994; Hills, King, & Armstrong, 2007).

Despite increasing risk for CVD among youth, the literature indicates that adolescents have a low perception of risks and poor knowledge regarding CVD outcomes and preventive measures (Collins, Dantico, Shearer, & Mossman, 2004; Vanhecke, Miller, Franklin, Weber, & McCullough, 2006). Vanhecke et al. (2006) addressed awareness, knowledge, and perceptions of CVD risks in 873 high school students in Michigan. Only 16.6% of the students selected CVD as their greatest perceived lifetime health risk; accidents (39.1%) and cancer (29.1%) were the top two greatest perceived lifetime health risks in this sample. Also, less than half of the students (42.3%) responded that CVD was the number one cause of death for men and only 14% thought that it was the number one cause of death for women. Perceived risk and cardiovascular knowledge seem to improve with increasing age, but there are still some misconceptions. Collins et al. (2004) examined CVD awareness and knowledge in an ethnically diverse sample of 1,481 college students in Arizona. Twenty-four percent of the students considered heart disease to be their greatest health risk while 44% and 24% perceived cancer and accidents, respectively, to be their greatest health risk. Forty-nine percent believed that Whites were most at risk for CVD compared to Blacks, Hispanics, Native Americans, and Asians. Furthermore, 66% of the college students in this study believed that heart disease was the second leading cause of death (i.e., second to cancer) for women.

Findings from the Collins et al. (2004) and Vanhecke et al. (2006) studies suggest that youth are more likely to endorse accidents and cancer as health risks. Given the media campaigns addressing drunk driving, helmet use, and smoking targeted at youth, it is not surprising that they would endorse these health risks as more salient. In addition, youth report having more knowledge about sexually transmitted diseases (Collins et al., 2004), perhaps because information on STDs is readily available at school or provided by their physicians. In Collins et al., 88% of the sample reported that their physician had never discussed CVD or its risk factors. Perhaps youth do not perceive CVD as a health risk even in their lifetime because they are unaware of the risk factors and/or symptoms and do not view CVD as occurring now or in the future. However, development of cardiovascular related behaviors (e.g. eating habits and level of physical activity) is evident during adolescence, which may influence their risk for CVD in adulthood. Perhaps providing individuals with CVD information during adolescence may help to increase cardiovascular health knowledge, thus providing adolescents with the knowledge/skills to begin engaging in healthy lifestyle behaviors.

Measuring Health Knowledge

A structured method or measure of cardiovascular health knowledge has not been established. Measurements of health knowledge in previous studies have consisted of assessing awareness of the risk factors and possible disease outcomes. Recent studies have used open-ended questions such as "Can you tell me the major causes of heart disease or heart problems," that require the individual to list risk factors of which they are aware. The use of open-ended questions to assess knowledge allows the researcher to capture information that is salient to the participant. For instance, an individual that consumes fatty foods and has high blood pressure may readily respond with poor dietary intake as a modifiable risk factor for CVD. Although the ability to list CVD risk factors suggests increased awareness, knowledge of risk factors does not imply knowledge of how to reduce those risks.

Most studies have addressed knowledge of CVD risk factors by using a forced-choice format where individuals have to give a yes/no, true/false response, or choose the best answer in a multiple choice item. This format allows researchers to test knowledge on various content areas related to CVD such as cardiovascular health facts, nutrition, or physical activity as well as assess one's knowledge of health behaviors to reduce risks. However, the forced-choice format also allows an individual to get an item correct simply by guessing, which may interfere with the ability to examine true knowledge.

Predictors of Health Knowledge

Research suggests that ethnicity, gender, and education, are possible predictors of health knowledge (Collins et al., 2004; Vega et al., 1987). In a study examining nutrition knowledge in high school students, White adolescents scored significantly higher than African Americans, while Hispanic adolescents scored in the middle of Whites and African Americans (Beech, Rice, Myers, Johnson, & Nicklas, 1999). Furthermore, in the Beech et al. (1999) study, girls scored significantly higher on the nutrition knowledge scale compared to boys. For young adults participating in the CARDIA study (Lynch, Liu, Kiefe, & Greenland, 2006), White participants had higher knowledge regarding CVD risk factors compared to Black participants. Also, individuals with more than 12 years of education had higher CVD knowledge compared to those with 12 or fewer years of education (Lynch et al., 2006). Similar findings related to education and health knowledge were also found among an adult Canadian sample (Potvin, Richard, & Edwards, 2000). It should be noted that the results from the Beech et al., Lynch et al., and Potvin et al. studies were not assessing change in health knowledge. In contrast, the Harrell, Davy, Stewart, and King study (2005) and the Child and Adolescent Trial for

Cardiovascular Health or CATCH study (Edmundson, Parcel, Feldman, Elder, & Perry et al., 1996), did not find any significant race/ethnicity or gender differences in health knowledge after implementing a cardiovascular health intervention for adolescents. Findings from these two studies indicate the importance of cardiovascular health interventions and the result of improved health knowledge for all participants independent of race/ethnicity or gender. In summary, gender, ethnic, and educational differences in health knowledge exist among adolescents and young adults. These differences may be due to the type of measure used to assess knowledge, quality of education, or other disparities not yet addressed in the literature (e.g., lack of access to healthcare to obtain health information). However, studies that involve a cardiovascular intervention suggest no racial/ethnic group or gender differences in knowledge after the intervention has been implemented.

Interventions Aimed to Increase Cardiovascular Health Knowledge

Several school-based health interventions have been implemented addressing cardiovascular health. The CATCH study was a longitudinal, school-based intervention that addressed cardiovascular disease risk factors including dietary intake and physical activity (Edmundson et al., 1996). The intervention trial consisted of 96 elementary schools that were randomized into one of three treatment conditions: 1) the school-only condition, which received the CATCH health education curricula, a physical education program, a campus no-smoking policy, and a school food service intervention program; 2) the school plus family condition, which consisted of a home-based intervention in addition to the CATCH school intervention; and 3) the control condition, which only received the schools' standard health education curriculum. Dietary knowledge (i.e., knowledge about heart healthy foods) was assessed for third and fifth graders at the beginning and at the end of the school-year as well as the following two spring semesters after the intervention curriculum had been implemented. The dietary knowledge scale consisted of 14 items where participants had to decide which choice was more heart healthy (i.e., lower fat or lower sodium). An example included deciding if whole wheat bread or white bread was better for one's health. Cronbach's alpha for the scale was 0.76 and 0.78 for the third and fifth grade samples, respectively. Results of the CATCH intervention indicated that dietary knowledge increased significantly within the school-only and school plus family conditions, and this improvement was sustained over three years.

The Physical Activity and Teenage Health (PATH) program was a school-based intervention aimed to reduce coronary disease risk factors and modify health behaviors in 346 predominantly ethnic minority students attending an inner-city public high school (Fardy, White, Haltiwanger-Schmitz, Magel, McDermott et al., 1996). Students either participated in a health promotion intervention consisting of an exercise program, health education, and behavior modification or they participated in regular physical education volleyball classes. The intervention involved 20-25 minutes of circuit training and 5 minutes of health behavior lecture-discussion every day for 11 weeks. Cardiovascular health knowledge was measured pre- and post-intervention and consisted of a 50-item multiple-choice test specifically developed for the PATH program and based on the health behavior lectures and discussions (examples of items and psychometrics were not provided for this scale). Cardiovascular health knowledge mean scores significantly increased for the intervention group, but declined for the control group. Despite an increase in knowledge for the intervention group, overall intervention participants still only answered about half of the items correctly at posttest. These findings suggested that 5 minutes each week was not enough time to cover all of the CVD related health areas in depth.

Harrell et al. (2005) examined the effectiveness of a school-based intervention to increase health knowledge of CVD in 205 fifth-grade students. The intervention lasted 16 weeks and consisted of four heart healthy educational sessions taught by medical professionals. Furthermore, teachers incorporated information from the sessions into lesson plans and exams. The control group consisted of a school that only received baseline and post testing. Cardiovascular health knowledge was assessed using the "Know Your Body" questionnaire, which is a health questionnaire that covered several areas related to cardiovascular health including diet, physical activity, body weight, and smoking. The health knowledge questionnaire consisted of 34 items and had a test-retest reliability of 0.80 for a 1-week interval in a middle school sample (Williams, Carter, & Eng, 1980). Response options consisted of true, false, and don't know in order to reduce guessing. Example of items on the questionnaire included, "Regular physical exercise may help delay or prevent a heart attack" or "People with high blood pressure need to reduce their salt intake." Results indicated that the percentage of correct responses on the questionnaire significantly increased from 48% to 60% for the intervention group. Health knowledge did not significantly change for the control group.

The FAST Stroke Prevention Educational Program consisted of a 2-month stroke prevention program focused on improving knowledge of stroke signs and symptoms, attitude toward stroke, and risk reduction behaviors in rural Mississippi middle school students (Miller, King, Miller, & Kleindorfer, 2007). Health knowledge was assessed with the use of only two questions with a maximum score of 10 points for each question. The first question assessed student's knowledge of stroke signs and symptoms and the second question examined knowledge of stroke risk factors. Psychometrics was not provided and it is not clear if the two questions were open-ended or forced choice (i.e., true/false or multiple choice). The intervention consisted of a 50-minute presentation (both lecture and behavioral training) on stroke signs, symptoms, risk factors, and behaviors related to stroke occurrence in adulthood. Participants completed a pretest, an immediate posttest (i.e., after the 50-minute presentation), and a long-term posttest at 2 months after the presentation. Results included a significant increase in knowledge of stroke signs, symptoms, and risk factors at immediate and long-term posttests.

In summary, previous school-based cardiovascular health related interventions have been successful in improving CVD health knowledge in youth. Also, these interventions appeared to be effective across various school-age groups and environments (e.g., rural versus inner-city). However, the previously reviewed interventions consisted of different protocols, various time-lengths, and different measures for assessing CVD related health knowledge. The previous studies reported good internal consistency for the measures used (i.e., .76 to .78 for CATCH and .80 for the Know Your Body Questionnaire), but there were no further details about internal structure (i.e., did the items measure the construct that was intended to be measured) or properties of the items (e.g., difficulty or discrimination). This additional information is important in terms of establishing the validity of the measure as well as determining whether the items adequately distinguish those with high health knowledge from those with low. In addition to assessing health knowledge, some of the previously reviewed interventions also examined dietary and physical activity changes (Edmundson et al., 1996; Fardy et al., 1996; Harrell et al., 2005), but did not address if any improvements in diet and physical activity were related to an increase in health knowledge.

Does the Health Knowledge-Behavior Link Exist?

According to the knowledge-attitude-behavior (KAB) model, knowledge is thought to accumulate overtime, which causes changes in attitudes and/ or behaviors (Allport, 1935; Baranowski, Cullen, Nicklas, Thompson, & Baranowski, 2003). Cardiovascular disease health knowledge is thought to be required in order to make health decisions and initiate behavior change (Homko, Santamore, Zamora, Shirk, Gaughan et al., 2008; Potvin et al., 2000). Recent research indicated that CVD health knowledge was marginally associated ($p < .06$) with less increase in body mass index (BMI) 10 years later in Black and White young adults (Lynch, Liu, Kiefe, & Greenland, 2006). However, in this same study, CVD health knowledge was not associated with 10-year changes in other CVD risk factors (i.e., cholesterol, smoking, blood pressure, and physical activity level). Some studies suggest that even though youth are knowledgeable, they may still engage in unhealthy behaviors (Frost, 1992). Smalley, Wittler, and Oliverson (2004) conducted a survey with 13-18 year olds regarding their attitudes and health habits related to CVD. Most of the participants, particularly the older participants, strongly agreed that smoking cigarettes, being overweight, and eating a high fat diet were risk factors for CVD. However, a majority of the sample was considered overweight (BMI $\geq 95^{th}$ percentile), smoked at least one cigarette per day, and ate fast food at least two times per week.

Evidence that change in health knowledge directly predicts behavioral change is weak (Baranowski et al., 2003). However, literature suggests that self-efficacy, the perceived ability to produce a desired effect (Bandura, 1986), and readiness for change (Prochaska & DiClemente, 1984) may possibly play a role in the health knowledge and behavior link. Rimal (2000) examined diet self-efficacy as a possible mediator for the relationship between diet knowledge and eating behaviors in 12-74 year old individuals participating in the Stanford Five-City Project. Results indicated that self-efficacy mediated the knowledge and behavior relationship given that individuals who had high self-efficacy also had the highest knowledge and behavior correlation. Also, those who had an increase in self-efficacy over time were more likely to have an increased knowledge and behavior correlation at follow-up compared to baseline. Previous studies also indicate that individuals in the pre-contemplation stage tend to have significantly lower health knowledge such as knowledge of tobacco health effects (Cohen, Pederson, Ashley, Bull, Ferrence et al., 2002) or importance of physical activity (Lee, 1993) compared to individuals in the preparation or action stages.

Literature suggests that a significant link between health knowledge and behavior may only apply to individuals who are motivated to make changes, have the resources to implement change, and perceive some personal vulnerability (Baranowski et al., 2003; Smalley et al., 2004). These are usually individuals in the preparation and action stages of readiness for change. Previous studies addressing nutrition knowledge included assessments of self-efficacy and stage of change, but did not examine the relationship among these three factors (Beech et al., 1999; Gracey, Stanley, Burke, Corti, & Beilin, 1996). However, findings from each study suggested that individuals who had higher nutritional knowledge also had higher self-efficacy and were more likely to be in the preparation or higher stage of change. Perhaps an increase in health knowledge, which can be considered an improvement in ability or development of skills, increases one's confidence (i.e., self-efficacy) to make health behavior changes. In addition, level of knowledge may be associated with whether the individual is contemplating, preparing, acting on, or maintaining behavioral changes.

In summary, the prevalence of CVD risk factors such as obesity, elevated blood pressure, hyperlipidemia, physical inactivity, and poor nutrition is increasing among youth. Being overweight and having elevated blood pressure during adolescence places youth at a higher risk for developing CVD during adulthood. Despite increased presence of CVD risk factors, previous research suggests that youth do not perceive CVD as a health risk and tend to lack knowledge regarding CVD and its risk factors. Previous interventions have proven to be effective in improving health knowledge in adolescents, but there are still a number of gaps in the literature concerning the relationship among cardiovascular health knowledge and behavior change. The KAB model states that knowledge precedes behavior and one must have knowledge of risk factors, potential outcomes, and healthy behaviors before deciding to make a behavior change. However, evidence for the KAB model is weak, which may be related to how knowledge is assessed as well as the exclusion of potential mediators such as self-efficacy and readiness for change in health behavior change models.

The purpose of this current study was to examine the influence of CVD health knowledge on health behavior change (i.e., dietary and physical activity changes) in 15-17 year olds with elevated blood pressure participating in Project Adolescent

Cardiovascular Evaluation (Project ACE), a cardiovascular lifestyle intervention. The four main objectives included: 1) examining the psychometrics of a health knowledge measure developed for Project ACE; 2) examining parental education, gender, and race/ethnicity as predictors of health knowledge; 3) testing the effectiveness of a cardiovascular lifestyle intervention for adolescents with elevated blood pressure on change in health knowledge; and 4) analyzing the direct and indirect effects of nutrition and exercise knowledge on dietary and physical activity behavioral changes, respectively, via self-efficacy and readiness for change.

Chapter 2: Method

Participants

Prospective participants for Project ACE, age 15-17, were identified during an annual high school blood pressure screening from 2000-2005. Eligibility criteria consisted of having elevated blood pressure (i.e., systolic blood pressure and/or a diastolic blood pressure greater than or equal to the 90th percentile adjusted for sex, age and height), but less than 160/100, and living in the United States for at least four years. Exclusion criteria included taking medication with cardiovascular effects and having a history of the following: heart disease, secondary hypertension, renal disease, cancer, diabetes, asthma or other respiratory conditions, severe allergies, major psychological disorder, developmental disabilities, or any condition that would prevent participation in physical exercise. Home visits were conducted with eligible participants from the school screen. Participants with an elevated blood pressure at the home visit were asked to attend baseline assessments. There were 201 participants that completed baseline assessments, but only 167 (118 boys, 49 girls) agreed to continue with participation in the intervention and were randomized into a treatment condition (i.e., minimal, moderate, or intense). Mean age for the randomized sample was 16.2 years and ethnic background consisted of 47% Hispanic, 35% Black, 10% White, and 8% 'Other.' There were 58 adolescents randomized to the minimal condition, 63 in the moderate condition, and 46 adolescents in the intense condition.

Procedures

Informed consent was obtained from each participant at a home visit during which eligibility for the study was determined. Demographic variables such as age, gender, and parent education were also obtained during the home visit. Participants that had elevated blood pressure during the home visit were asked to participate in the intervention study. Participants who agreed underwent a number of assessments prior to being randomized into a treatment condition.

Medical Screen

During the medical screen visit, blood pressure measurements, body size measurements (i.e., height, weight, and waist circumference), and a 24-hour dietary recall were completed for each participant. Participants also completed several psychosocial questionnaires including the Health Knowledge Assessment, Self-efficacy Questionnaire, and the Diet, Exercise, and Stress Management Stages of Change Questionnaire (DESM-SCQ). These measurements, with the exception of the Health Knowledge Assessment, were collected up to five times (i.e., every three months after randomization up to one year) during follow-up medical screen visits. The Health Knowledge Assessment was completed at baseline and post-intervention. This current study only used the first three times (6 months of data) in the analyses.

<u>Blood Pressure and Body Size Measurements.</u> Before blood pressure was measured, the participant rested quietly for 5 minutes with the right arm at heart level. At 5 minutes the first blood pressure reading was taken using a manual mercury sphygmomanometer. Blood pressure was measured again at 7 minutes and 9 minutes and the average of the last two readings was used in the analyses. Weight was measured in

pounds and height was recorded in inches and converted to kilograms and meters, respectively. Body mass index (BMI) was calculated (kg/ m^2).

Health Knowledge Assessment (See Appendix). The Health Knowledge Assessment consisted of 34 multiple choice items. Participants received the Health Knowledge Assessment during the first medical screen (i.e., baseline) and immediately post-intervention (i.e., 3 months after randomization for the minimal and moderate conditions and 6 months after randomization for the intense condition). Evidence of content-based validity was supported by use of a panel of experts to create items based on empirically supported cardiovascular health research as well as content provided in the Project ACE manual and intervention sessions. A variety of items were developed in order to represent the different risk factors for cardiovascular disease including 7 items on blood pressure, 11 items on nutrition, 5 items on physical activity/ exercise, and 11 items on stress management. The panel of experts reviewed the content of each item and decided the items were appropriate for the purpose of the test. Cronbach's alpha for the scores obtained using the 34-item measure was .65 and .74 at pretest and posttest, respectively.

24-hour Dietary Recall (See Appendix). A trained research assistant administered the 24-hour dietary recall. The participant reported the type and amount of food or drink consumed the day before for meals and snacks as well as vitamins and minerals. During this recall, the research assistant provided the participant with food models (measuring cups, bowls, spoons, and 2-D food model poster) to facilitate reporting in a structured and standardized manner. Participants also reported if the amount and type of foods consumed were considered typical. The Nutritionist Pro version 2.3.0 (First DataBank, Inc., San Bruno, CA) was used to derive amount and percentage of nutrients consumed. Dietary data (i.e., saturated fat, sodium, dietary fiber, and sugar) collected at baseline and subsequent appointments up to 6 months were analyzed. Child and adolescent studies suggest using multiple 24-hour dietary recalls to assess dietary intake (Falciglia, Troyer, & Couch, 2004). This study used the average of two 24-hour dietary recalls at each time.

Diet, Exercise, and Stress Management Stages of Change Questionnaire (DESM-SCQ) (See Appendix). The DESM-SCQ is based on the Stages of Change Model (Prochaska & DiClemente, 1983) and consists of four items each with five response options. Each item represents a stage (i.e., pre-contemplation, contemplation, preparation, action, and maintenance). In the first section, the participant is asked to endorse which statement is most true for them regarding consumption of fatty or fried foods. For example, a pre-contemplator may endorse the statement "I currently eat a lot of fatty or fried foods and I do not intend to eat less fatty or fried foods in the next 6 months" or an individual in the maintenance stage may state, "I do not eat fatty or fried foods and have done so for more than 6 months." The second section has similar statements, but in reference to eating a healthy diet. Statements about exercise and stress management follow in the third and fourth sections, respectively. This current study examined fatty/fried food (i.e., nutrition readiness for change) and exercise readiness for change at post-intervention.

Self-efficacy Questionnaire (See Appendix). The Self-efficacy Questionnaire was developed as part of the larger study and contained 30 items. Items were created by a panel of experts who considered components of the intervention and nominated items based on the relevance to the goal of improving dietary intake and physical activity.

Participants were asked to state on a 0-10 scale how confident or certain they feel they could complete the items which were lifestyle habits emphasized in the Project ACE intervention. The Self-efficacy Questionnaire was administered at each time point, but only post-intervention self-efficacy (i.e., self-efficacy at three months for the minimal and moderate conditions and at six months for the intense condition) was used in the analyses. Scores obtained using the six nutrition specific items had a Cronbach's alpha of .82 and scores using the two exercise items had a Cronbach's alpha of .66.

Fitness Assessment

During the fitness assessment visit, participants completed a maximal treadmill test as well as another 24-hour dietary recall. Administration of the 24-hour dietary recall consisted of the same procedures stated above. Dietary data from the medical screen and the fitness assessment were averaged together at each time. The exercise test consisted of a modified Balke (walk-jog) symptom-limited incremental treadmill exercise protocol to determine maximum/ peak VO_2. During the treadmill test, the initial workload was set at a speed of 4.5 mph with a 2.5% grade. Speed remained constant, but the grade was increased at the beginning of each 2 minute stage by 2.5%. Also during the test, expired gases were collected through a low resistance mass flow sensor and analyzed using a Sensor Medics Vmax229 metabolic cart. Maximal exercise performance was defined as a respiratory exchange ratio above 1.15, a maximal heart rate within 1 standard deviation of predicted values, or an inability of the participant to continue despite urging by the testing staff.

Project ACE Intervention

As previously mentioned, after the medical screen visit participants were randomized into one of three treatment conditions. The treatment conditions included minimal, moderate, and intense conditions (see Table 1 for treatment condition components). In the minimal condition participants attended one 90 minute session with their parent(s). During this session a trained research assistant provided information and recommendations regarding nutrition, exercise, and stress management. Both the participant and the parent received a workbook and were introduced to and practiced deep breathing during the session. Minimal condition participants received three monthly phone calls as well as two maintenance phone calls to assess their progress in reading the workbook and status on any lifestyle changes.

The moderate condition consisted of 10 group sessions lasting approximately 90 minutes each over the course of three months. Participants in this condition also received a workbook and were encouraged to bring it to each session. Session topics also covered nutrition, exercise, and stress management, but in more depth compared to the minimal condition. Moderate condition participants were also introduced to and practiced deep breathing and progressive muscle relaxation during the sessions and at home as a homework assignment. In addition to practicing relaxation techniques at home at least every other day, participants in this condition were also expected to exercise at least every other day for up to 30 minutes. Participants turned in a homework sheet each session to check their progress. Also, participants received six monthly phone calls to check the status of lifestyle changes after completing the intervention. Although parents did not attend group sessions with the participants as in the minimal condition, parents were offered the opportunity to attend two monthly parent sessions that provided an overview of the intervention and recommendations to help parents assist their children in making lifestyle changes.

The intense condition consisted of 12 group sessions also lasting 90 minutes, but over the course of 6 months. Nutrition, exercise, and stress management were also covered during the sessions based on materials in the provided workbook. In addition to the 12 group sessions, participants in the intense condition also attended 6 individual sessions, which were tailored to the specific needs of the participant. The intense condition included six monthly parent sessions to give parents an overview of the intervention, discuss the status of the lifestyle changes made by the participants, and help problem-solve in order to assist their children in meeting their health-oriented goals. Participants in this condition also received six monthly follow-up phone calls to track status of lifestyle changes after the initial six months.

Throughout this manuscript, pretest and posttest are used when referring to the Health Knowledge Assessment, Self-efficacy Questionnaire (nutrition and exercise subscales), and the DESM-SCQ (nutrition and exercise readiness for change). Baseline and post-intervention are used to refer to the Project ACE treatment conditions (i.e., minimal, moderate, and intense), dietary intake as measured by the 24-hour dietary recall, kilocalories expended per day, and peak VO_2. Furthermore, peak VO_2 and cardiorespiratory fitness are used interchangeably. Health knowledge score is used when explaining results of statistical analyses that use the sum of the items (i.e., observed variable). Level of health knowledge is used when explaining results of analyses that uses the latent variable for health knowledge.

Statistical Analyses

Descriptive statistics using Statistical Analysis Systems (SAS) version 9.1 were performed for demographic (age, gender, race/ethnicity, parent education, and family history), psychosocial (health knowledge, readiness for change, and self-efficacy), dietary (saturated fat, sodium, sugar, and fiber), and physiological variables (blood pressure, body size, cardiorespiratory fitness, and kilocalories expended per day). The data were screened to test assumptions of normality, independence, linearity, and randomness of the distribution of errors.

Objective 1: Examine psychometric properties of the Health Knowledge Assessment

Psychometric properties of the 34-item Health Knowledge Assessment were examined within a classical test theory (CTT) framework using SPSS version 16.0, within a confirmatory factor analysis (CFA) framework using Mplus version 5.2 (Muthén & Muthén, 1998-2002), and within an item response theory (IRT) framework using WINSTEPS. Analyses were conducted with all three frameworks to compare the findings. Each framework provides similar information such as internal consistency, item difficulty, and item discrimination, but under different assumptions. In addition, item and person parameters based on a CTT framework are sample and test dependent (Hambleton & Jones, 1993), which limits the information that can be obtained about the function of the actual item. The CFA and IRT models provide information about internal structure, item and person parameters, and factor scores using a latent variable approach, which controls for measurement error and is more "item based" (Hambleton & Jones, 1993).

Data from the Health Knowledge Assessment at pretest and posttest were examined separately. To increase the power for the analyses, all adolescents (i.e., randomized and non-randomized) with health knowledge assessment data were included. A total of 191 out of the 201 adolescents screened at baseline completed the pretest health knowledge assessment and 127 completed the assessment at posttest. For the CFA, a single factor model was tested at pretest and posttest with the factor loading of the first item fixed to 1 to set the metric. Then a second-order factor model was tested to examine possible nutrition, exercise, blood pressure, and stress management knowledge subscales. Configural invariance (i.e., items measure the same construct at different times) was tested by combining pretest and posttest data into the same model and correlating the error variances for each item across time.

IRT is a model-based approach to measurement that involves developing a model for each test item that gives the probability of a correct response as a function of the participant's true knowledge and the properties of the item (Embretson & Reise, 2000). There are several models used in IRT, but the current study applied a simple Rasch model. In the Rasch model, the dependent variable was the item response (correct or incorrect) and the independent variable was the participant's health knowledge, θ. Because the dependent variable is dichotomous and thus has an expected value that is bounded between 0 and 1, the Rasch model uses a nonlinear function linking the response variable to the independent variable. Information regarding item difficulty and item fit (i.e., infit and outfit) for each item were obtained from the IRT analyses.

Based on findings from the CTT, CFA, and IRT, health knowledge items that were considered to have good fit (i.e., item discrimination ≥ 0.2, significant factor loadings, and infit/outfit values between 0.7 – 1.3) were retained. The retained items were used to create a health knowledge latent variable at pretest and posttest, which was included in the analyses for Objectives 2 and 3.

Objective 2: Examine parental education, gender, racial/ethnic, and family history differences in health knowledge

Analyses to address Objective 2 included examining differences in the health knowledge latent variable at pretest and posttest by gender, race/ethnicity, and family history of high blood pressure (i.e., yes vs. no). In these analyses the factor loadings for each item were fixed to 1 in order to meet the assumptions of the Rasch model. Furthermore, item difficulties at posttest were fixed to item difficulties at pretest obtained from the IRT analyses in order to examine item gains in health knowledge by gender, race/ethnicity, and family history from pretest to posttest. The association between parental education and health knowledge at pretest and posttest was also examined.

Objective 3: Examine treatment condition differences in health knowledge

For Objective 3, treatment effects were examined by applying a MIMIC (multiple indicators and multiple causes) model approach. In the MIMIC model, item difficulties for the health knowledge latent variable at posttest were fixed to item difficulties at pretest in order to examine item gains. Treatment condition was dummy coded with two dummy vectors and the minimal condition was considered the reference group. The health knowledge latent variable was regressed on the two dummy vectors. Effect sizes were calculated using the following formula: $b/\sqrt{\text{variance}}$.

Objective 4: Test the direct and indirect effects of nutrition and exercise knowledge at post-intervention on dietary intake and physical activity, respectively, via self-efficacy and readiness for change

Mplus 5.2 was used to test several latent growth and structural equation models (SEM) for Objective 4. First, latent growth modeling was conducted to determine if there was a significant change in dietary intake (sodium, saturated fat, sugar, and fiber were modeled separately), level of cardiorespiratory fitness (i.e., peak VO_2), or kilocalories expended per day over the course of six months (i.e., time 1, 2, and 3). Then using the nutrition knowledge specific items and the exercise knowledge specific items from the Health Knowledge Assessment at posttest, two separate measurement models were tested. The posttest nutrition knowledge latent variable was included as a predictor of the slopes for each dietary variable and a posttest exercise knowledge latent variable was examined as a predictor of change in cardiorespiratory fitness and kilocalories expended per day in separate models controlling for gender, parent education, and treatment condition (two dummy vectors).

Because nutrition self-efficacy had more than three items, a measurement model was tested to see if a nutrition self-efficacy latent variable could be used rather than the observed variable. Including a latent variable in the model would provide more reliable information about the relationships because measurement error in nutrition self-efficacy would be controlled. In contrast, exercise self-efficacy was an observed variable and consisted of the sum of the ratings from the two exercise self-efficacy related items. The direct effects between health knowledge (nutrition and exercise) at posttest and self-efficacy (nutrition and exercise) as well as self-efficacy at posttest and change in diet and physical activity were tested in separate models. Based on results from these analyses, indirect effects on diet and physical activity were examined by including health knowledge (nutrition or exercise) at posttest, the relevant self-efficacy variable (nutrition or exercise), gender, and parent education in the model.

Although readiness for change is usually assessed as a categorical variable, the current study used the DESM-SCQ as a measure of readiness for change on a continuum (i.e., 0 – 4 scale) with a higher value indicating more readiness. The nutrition readiness for change item specifically asked the participant about readiness to change fatty or fried food intake. Exercise readiness for change was measured by a more general item regarding the participant's engagement in exercise. Similar to the analyses for self-efficacy, the direct effects between health knowledge (nutrition and exercise) at posttest and readiness for change (nutrition and exercise) as well as readiness for change at posttest and change in diet and physical activity were tested in separate models. Based on results from the direct effect analyses, indirect effects on change in diet and physical activity were examined by including health knowledge (nutrition or exercise) at posttest, the relevant readiness for change variable (nutrition or exercise), gender, and parent education in the model.

Chapter 3: Results

Sample characteristics presented in Table 2 and Table 3 were based on the 167 (29% girls) adolescents that were randomized into one of the three treatment conditions. Overall, parents of the adolescents had obtained a high school diploma or more (parental years of education $M = 13.26$, $SD = 2.61$), 44% of the sample endorsed having a parent with high blood pressure, and 64% endorsed having a family history (i.e., parents and/or grandparents) of high blood pressure. There were no significant differences in blood pressure (as expected), BMI, dietary intake, or physical fitness at baseline among the three treatment conditions. In contrast, the moderate condition consumed significantly more sugar compared to the minimal condition at post-intervention [$F(2) = 3.29$, $p < .05$]. Furthermore, the intense condition had a significantly higher nutrition self-efficacy [$F(2) = 2.97$, $p = .05$], nutrition readiness for change [$F(2) = 6.78$, $p < .01$], and exercise readiness for change [$F(2) = 10.79$, $p < .001$] compared to the minimal condition at posttest. Intense condition also had higher nutrition [$F(2) = 6.78$, $p < .01$] and exercise readiness for change [$F(2) = 10.79$, $p < .001$] than the moderate condition at posttest. There were no significant treatment differences at post-intervention for saturated fat, fiber, or sodium intake as well as cardiorespiratory fitness or kilocalories expended per day. In terms of exposure to intervention material (not reflected in tables), the moderate condition participants attended on average 86% of their group sessions and the intense condition participants attended an average of 80% of group and individual sessions. Since participants were allowed to make-up missed sessions, the moderate condition participants were exposed to an average of 94% and the intense condition participants were exposed to an average of 90% of the intervention material.

Objective 1: Examine psychometric properties of the Health Knowledge Assessment

Classical Test Theory (CTT). Table 4 displays the means, standard deviations, and corrected item-total correlations for the 34-item Health Knowledge Assessment at pretest and posttest. Cronbach's alpha for the summated scores obtained from the 34-item assessment at pretest was 0.65. There were only 15 items that met criteria for good item discrimination (i.e., corrected item-total correlation > 0.20). When examining the 34 items at posttest (Cronbach's alpha = 0.74), there were 24 items with good item discrimination. Items with corrected item-total correlations less than 0.20 suggest that those items may not be measuring the same construct and should perhaps be removed.

Confirmatory Factor Analysis (CFA). Internal structure evidence of validity was obtained from CFAs conducted on the 34-item assessment at pretest and posttest. Results indicated that a single factor model had good fit at pretest [$\chi^2(127) = 133.62$, $p = 0.33$, CFI = 0.97, RMSEA = 0.02, and WRMR = 0.88] and good fit according to 3 out of 4 criteria at posttest [$\chi^2(83) = 99.70$, $p = 0.10$, CFI = 0.84, RMSEA = 0.04, and WRMR = 0.94]. This evidence supported valid scores because most of the items were consistently measuring the same construct. Standardized factor loadings for each item at pretest and posttest can be seen in Table 5. Items 2, 6, 7, 10, 12, 14, 19, 25, 26, 27, 28, and 33 at pretest and items 4, 6, 7, 10, 12, 14, 18, 24, and 28 at posttest did not load significantly onto the one factor, suggesting that these items are not as strongly related to the underlying construct (i.e., health knowledge) compared to the other items. Some of these items also had poor item discriminations at pretest and posttest according to the CTT analysis, which suggest consistency between the two methods. Configural invariance was confirmed with good model fit [$\chi^2(124) = 140.58$, $p = 0.15$, CFI = 0.90, RMSEA =

0.03, and WRMR = 0.95] when the error variances for each item at pretest were correlated with the error variances for the items at posttest. These findings suggest that the items measure the same construct at pretest and posttest.

A second-order factor analysis with subscales (i.e., blood pressure, nutrition, exercise, and stress management knowledge) was tested, but did not have good model fit. In addition, two separate measurement models were tested in order to later examine the relationship between specific health knowledge at posttest (i.e., nutrition and exercise knowledge) and change in dietary intake and physical activity/fitness. Items that did not significantly load onto the single factor model at posttest and had poor item discriminations were removed in these analyses. The items were 4, 6, 7, 10, 12, 14, 18, 24, and 28 leaving 8 nutrition related items and 4 exercise items. Measurement models for nutrition knowledge [$\chi^2(16) = 11.19$, $p = 0.80$, CFI = 1.00, RMSEA = 0.00, and WRMR = 0.57] and exercise knowledge [$\chi^2(2) = 1.62$, $p = 0.44$, CFI = 1.00, RMSEA = 0.00, and WRMR = 0.30] at posttest had good model fit. Table 6 displays standardized factor loadings, standard errors, and *p*-values for the nutrition and exercise measurement models at posttest.

Item Response Theory (IRT). The weighted fit indices (infit and outfit statistics) as well as the *z* statistics for each item are presented in Table 7. At pretest, items 7, 12, 19 and 29 had either a weighted mean square statistic or a *z* statistic outside of the acceptable ranges (i.e., 0.7-1.3 for weighted mean square statistic and ≥ 2.0 for *z* statistic). These findings suggest that these items did not fit the IRT model at pretest, possibly due to having low item discriminations as indicated in the CTT analysis. Furthermore, items 7, 12, 14, and 28 at posttest had fit statistics outside of the acceptable ranges. Table 8 displays the item difficulties for each item at pretest and posttest. Item difficulties were based on the parameters calculated in the Rasch model analysis. The metric at both pretest and posttest was set by setting the mean item difficulty to zero, therefore, allowing comparisons to be made across pretest and posttest because they were centered at the same value. Figure 1 and Figure 2 present the item-person maps for the health knowledge assessment at pretest and posttest. Item difficulties and participant latent trait ability (i.e., health knowledge) are on the same metric using a logit scale, which is centered at a mean of zero. Items located at zero would be considered moderately difficult and adolescents at this level would have a moderate level of health knowledge. Hard items and adolescents with high levels of health knowledge are located above zero (positive logits). Easy items and adolescents with low levels of health knowledge are located below zero (negative logits). At pretest the item difficulties map well onto the distribution of the participant's latent trait ability, with the exception of item 4 which is extremely easy. These findings suggest that the items are targeting adolescents with variable levels of health knowledge. On the other hand, the item-person map at posttest is misaligned and additional hard items are needed to target the adolescents with high levels of health knowledge. The change in fit between item difficulty and participant level of ability from pretest to posttest may be related to intervention effects. Some items at pretest that were considered hard became easier at posttest after adolescents completed the intervention (see Table 8). In Objectives 2 and 3 item difficulties for posttest were fixed to those of the pretest in order to assess item gains.

In summary, the CTT results indicated that there were several items with poor psychometric properties, which were also consistently indicated in the CFA and IRT results. The CFA results suggested a single factor model at both pretest and posttest and additional analyses confirmed configural invariance. A second-order factor model did not fit the data, but there was good model fit for the nutrition and exercise knowledge measurement models. In the IRT, four items at pretest and posttest had significant lack of fit with the Rasch model. Results from the IRT also indicated that items from the Health Knowledge Assessment covered a wide range of difficulty levels as well as targeted a wide range of ability levels at pretest and posttest. Although the item-person map at posttest indicated the need for more hard items, these findings actually suggested the effectiveness of the intervention on improving health knowledge. There were 17 items at pretest that were considered easier at posttest.

Based on results from the CTT, CFA, and IRT, several items were removed to improve internal consistency and model fit of the Health Knowledge Assessment at posttest. Items 4, 6, 7, 10, 12, 14, 18, 24, and 28 were removed in remaining analyses due to having poor item discrimination (i.e., corrected item-total correlation < 0.2 and/ or non-significant factor loading) and lack of fit with the Rasch model. Scores obtained from the 25 remaining items had a Cronbach's alpha of .66 at pretest and .77 at posttest. Model fit was good for a single factor model with the 25 items as indicators at pretest [$\chi^2(102) = 109.84$, $p = 0.28$, CFI = 0.97, RMSEA = 0.02, and WRMR = 0.86] and at posttest according to 3 out of 4 fit criteria [$\chi^2(69) = 86.20$, $p = 0.08$, CFI = 0.88, RMSEA = 0.04, and WRMR = 0.93].

Objective 2: Examine parental education, gender, racial/ethnic, and family history differences in health knowledge

In the set of analyses for Objective 2 the factor loadings for each health knowledge item was fixed to 1 to meet the assumptions of the Rasch model (i.e., item discrimination for each item was equal to 1). Parental education was positively associated with the health knowledge latent variable at pretest ($\beta = .03$, $SE = .01$, $p = .05$), suggesting that as parental years of education increased, so did the health knowledge of the participant at baseline. However, at posttest, parental education was not associated with level of health knowledge ($\beta = .03$, $SE = .02$, $p > .05$). There were significant gender differences in level of health knowledge at pretest ($\beta = -.22$, $SE = .08$, $p < .01$), with boys having higher health knowledge compared to girls. Furthermore, White adolescents had a higher level of health knowledge at pretest compared to Blacks ($\beta = -.35$, $SE = .11$, $p < .001$) and Hispanics ($\beta = -.22$, $SE = .10$, $p < .05$). Adolescents that had a family history of high blood pressure had a higher level of health knowledge at pretest than those who did not endorse having a family history of high blood pressure ($\beta = .19$, $SE = .07$, $p < .01$). There were no gender ($\beta = -.12$, $SE = .10$, $p > .05$), race/ethnicity (Blacks $\beta = -.24$, $SE = .13$, $p > .05$; Hispanics $\beta = -.19$, $SE = .12$, $p > .05$), or family history ($\beta = .13$, $SE = .09$, $p > .05$) differences at posttest. Although the previous findings were based on analyses using the health knowledge latent variable, Table 9 presents the mean health knowledge scores (calculated from the 25 retained items) by sex, race/ethnicity, and family history of high blood pressure. In this table it should be noted that there is a significant 3 to 4 point increase in mean health knowledge scores across sex, racial/ethnic groups, and family history from pretest to posttest.

Objective 3: Examine treatment condition differences in health knowledge

Results reported in Table 9 also indicate an increase in mean health knowledge scores from pretest to posttest for each treatment condition. More specifically, health knowledge score for the minimal condition increased an average of 1.17 ($d = .24$, $p < .05$) points whereas the moderate and intense conditions increased an average of 3.89 ($d = 1.09$, $p < .001$) and 4.76 ($d = 1.16$, $p < .001$) points, respectively. Differences among the treatment conditions on level of health knowledge were examined using the health knowledge latent variable at pretest and posttest. There were no significant differences between treatment conditions for level of health knowledge at pretest. When item difficulties at posttest were fixed to those at pretest to examine item gains, there were treatment effects. At posttest, the intense condition had a significantly higher level of health knowledge compared to the minimal ($\beta = .49$, $SE = .12$, $p < .001$; $d = 1.12$) and moderate conditions ($\beta = .26$, $SE = .11$, $p < .05$; $d = .59$). Furthermore, the moderate condition had a significantly higher level of health knowledge than the minimal condition ($\beta = .23$, $SE = .11$, $p < .05$; $d = .53$). These findings suggest that the intervention, specifically the moderate and intense treatment conditions, were effective in improving adolescents' cardiovascular health knowledge.

Objective 4: Test the direct and indirect effects of nutrition and exercise knowledge at posttest on dietary intake and physical activity, respectively, via self-efficacy and readiness for change

<u>Modeling change in diet and physical activity variables.</u> There was a significant decrease in saturated fat intake ($b = -.52$, $SE = .26$, $p < .05$), suggesting that participants consumed an average of .52 grams less saturated fat per month. The latent growth model

for change in saturated fat over six months had good model fit when the change parameter was specified as a fixed effect [$\chi^2(3) = .873$, $p = 0.83$, CFI = 1.00, RMSEA = 0.00, and SRMR = 0.03]; however this model suggested that there were no individual differences in the slope to be predicted. According to the means (see Table 10), sodium intake increased over the course of six months and there was no linear change in sugar or fiber, thus, analyses with saturated fat, fiber, sugar, and sodium intake consisted of cross-sectional analyses examining the association between these dietary variables at post-intervention and the nutrition knowledge latent variable at posttest. For these cross-sectional analyses, the sample was further reduced to include only those participants that endorsed consuming a typical amount of food on the 24-hour dietary recall at post-intervention (see Table 11). There was also no linear change in cardiorespiratory fitness (i.e., peak VO_2) or kilocalories expended per day over the course of six months. Cross-sectional analyses with peak VO_2 and kilocalories expended per day at post-intervention and exercise knowledge latent variable at posttest were also conducted.

Health knowledge and health behavior associations using structural equation modeling (SEM). Level of nutrition knowledge at posttest was not significantly associated with saturated fat ($\beta = .20$, $SE = 2.51$, $p > .05$), fiber ($\beta = .24$, $SE = 1.73$, $p > .05$), sodium ($\beta = .17$, $SE = 2.71$, $p > .05$), or sugar intake ($\beta = -.20$, $SE = -13.44$, $p > .05$) at post-intervention controlling for gender, parent education, and treatment condition (two dummy vectors). Furthermore, level of exercise knowledge at posttest was not significantly related to peak VO_2 ($\beta = .23$, $SE = 2.03$, $p > .05$) or kilocalories expended per day at post-intervention ($\beta = .07$, $SE = .99$, $p > .05$) controlling for gender, parent education, and treatment condition.

Self-efficacy and readiness for change. Nutrition self-efficacy was marginally associated with level of nutrition knowledge at posttest (see Figure 3; $\beta = .25$, $SE = .25$, $p < .10$) and the model had good fit [$\chi^2(45) = 49.94$, $p = .28$, CFI = .96, RMSEA = 0.03, and WRMR = 0.80]. For every 1-point increase in level of nutrition knowledge at posttest there was a marginally significant (i.e., $p = .08$) .62 point increase in nutrition self-efficacy at post-intervention. Nutrition readiness for change, however, was not associated with level of nutrition knowledge ($\beta = .25$, $SE = .16$, $p > .05$). Furthermore, level of exercise knowledge was not associated with exercise self-efficacy ($\beta = -.82$, $SE = .66$, $p > .05$) or exercise readiness for change at posttest ($\beta = .16$, $SE = .19$, $p > .05$).

Although the models had good fit, nutrition self-efficacy at posttest was not significantly associated with fiber intake ($\beta = -.14$, $SE = .12$, $p > .05$), sodium intake ($\beta = -.05$, $SE = .11$, $p > .05$), or saturated fat intake ($\beta = -.14$, $SE = .11$, $p > .05$) at post-intervention. However, there was a significant association between nutrition self-efficacy and sugar intake (see Figure 4) controlling for gender, parent education, and treatment condition ($\beta = -.28$, $SE = .10$, $p < .01$). For every 1-point increase in nutrition self-efficacy at posttest there was a 10 gram decrease in sugar intake at post-intervention. Nutrition readiness for change was also correlated with sugar intake (see Figure 5) at post-intervention ($\beta = -.24$, $SE = .11$, $p < .05$). For every 1-point increase in nutrition readiness for change at posttest there was a 20 gram decrease in sugar intake at post-intervention. However, nutrition readiness for change was not associated with saturated fat intake at post-intervention ($\beta = -.19$, $SE = .12$, $p > .05$). Exercise self-efficacy was not significantly associated with peak VO_2 ($\beta = -.20$, $SE = .22$, $p > .05$) or kilocalories expended per day ($\beta = .28$, $SE = .36$, $p > .05$) at post-intervention. Readiness for change was also not significantly associated with peak VO_2 ($\beta = .11$, $SE = .10$, $p > .05$) or kilocalories expended per day ($\beta = -.02$, $SE = .11$, $p > .05$).

In summary, the latent growth modeling was only conducted with saturated fat intake because there was no linear change in fiber, sugar, peak VO_2, or kilocalories expended per day and there was an increase in sodium intake over the course of six months. Saturated fat had a negative, significant slope, indicating that saturated fat intake decreased an average of .52 grams per month; however there were no individual differences in the slope to be modeled. Level of nutrition knowledge at posttest was not significantly related to saturated fat, fiber, sugar, or sodium intake at post-intervention. However, level of nutrition knowledge at posttest was marginally, significantly related to nutrition self-efficacy at posttest. Nutrition self-efficacy and nutrition readiness for change were negatively associated with sugar intake at post-intervention. Level of exercise knowledge, exercise self-efficacy, and exercise readiness for change were not significantly related to peak VO_2 or kilocalories expended per day at post-intervention.

Chapter 4: Discussion

The current study had four main objectives: 1) to examine the psychometric properties of the Health Knowledge Assessment developed for Project ACE using CTT, CFA, and IRT; 2) to examine the associations between health knowledge and gender, race/ethnicity, parent education, and family history of high blood pressure at pretest and posttest; 3) to test treatment effects on health knowledge at pretest and posttest; and 4) to examine the direct and indirect effects of nutrition and exercise knowledge on dietary intake and physical activity, respectively, via self-efficacy and readiness for change.

Findings indicated that the 34-item Health Knowledge Assessment had good internal consistency, the items loaded onto a single factor at pretest and posttest, and there was evidence of configural invariance. Furthermore, there was a good distribution of easy, moderate, and hard items at pretest, but additional hard items were needed at posttest given the improvement in scores. Nine items had poor item discriminations and/or lack of fit with the Rasch model and were removed for the remaining analyses. There were gender, race/ethnicity, parent education, and family history of high blood pressure differences in level of health knowledge at pretest, but not at posttest. Mean health knowledge scores significantly improved across gender, racial/ ethnic groups, and for adolescents with or without a family history of high blood pressure. Also, there were significant increases in mean health knowledge scores across treatment conditions with the moderate and intense conditions having larger increases compared to the minimal condition. Although there were no treatment condition differences in level of health knowledge at pretest, the intense condition had significantly higher health knowledge than the minimal and moderate conditions at posttest. Furthermore, level of health knowledge for the moderate condition was significantly higher than the minimal condition at posttest.

There were no significant changes in dietary intake or physical activity over time. Level of nutrition knowledge at posttest was not associated with any of the dietary intake variables nor was level of exercise knowledge associated with the two physical activity variables at post-intervention. There was a marginally significant association between level of nutrition knowledge and nutrition self-efficacy at posttest. Nutrition self-efficacy and nutrition readiness for change at posttest were also associated with a decrease in sugar consumption at post-intervention. Exercise self-efficacy and exercise readiness for change were not associated with exercise knowledge, kilocalories expended per day, or cardiorespiratory fitness.

Psychometric properties of the Health Knowledge Assessment

Scores obtained from the 34-item Health Knowledge Assessment had a Cronbach's alpha of .65 and .74 at pretest and posttest, respectively. In addition to obtaining internal consistency for the measure, using the additional psychometric frameworks provided information about the discrimination, difficulty, and fit of the items as well as internal structure of the measure in order to better determine whether or not the set of items properly measured the construct of health knowledge. Confirmatory factory analysis results supported a single factor model at pretest and posttest, suggesting that the construct of health knowledge consist of information about nutrition, exercise, blood pressure, and stress management. Furthermore, configural invariance suggested that the items measured the same construct at pretest and posttest. According to the item-person maps, at pretest items mapped well onto person latent trait ability (i.e., health knowledge score) with the exception of one very easy item (item 4 – “Which of the following is not suggested to help high blood pressure?”) and two difficult items (item 19 – “How many extra calories must you consume to gain one pound?” and item 29 – “Which is not one of the three A’s of stress management?”), suggesting that the remaining items had good coverage of the health knowledge construct. At posttest there was a clear improvement in health knowledge scores, but a need for additional harder items. Perhaps parallel forms could have been used, parallel meaning that items from both forms measure a single construct (i.e., health knowledge), but the posttest form would have more items that assessed critical thinking skills (i.e., ability to apply newly gained knowledge) instead of basic memorization. Difficulty among the items varied and in some cases decreased from pretest to posttest. Items that were consistently easy such as item 4 suggested the answer for this particular item was either not hard to distinguish from the options (i.e., regular exercise, medications, stress reduction, or increase in salt consumption) and/or this item was not contributing a large amount of information about the health knowledge of the participants.

Based on the corrected item-total correlations from the CTT analysis and the factor loadings from the CFA, there were a number of items at pretest and posttest that had poor item discriminations (i.e., items were not consistently measuring the same construct as the other items). Items that consistently had poor item discrimination from pre to posttest included 7, 12, 14, and 28. In addition, the weighted fit indices estimated in the IRT analysis for these four items suggested lack of fit with the Rasch model. The Rasch model assumes that discrimination for each item is equal to 1. The four items asked the following: item 7 – “Which of the following does not indicate the correct number of servings a day that you should eat?"; item 12 –"What minerals have a positive effect on blood pressure?"; item 14 – "How much sodium is recommended per day?"; and item 28 – "Which is not a characteristic of automatic thoughts?" These items were perhaps measuring something in addition to health knowledge. For instance, since the answer for item14 was provided in milligrams in the intervention manual (i.e., the amount of sodium recommended per day), this item assessed math skills in addition to knowledge because the participant had to be able to convert milligrams into grams. For items 7, 12, and 28, it is not as obvious why these items had poor discriminations. Perhaps these items were assessing vocabulary skills in addition to health knowledge. For instance, participants had to be familiar with the word 'servings' to answer 7, 'minerals' for 12, and 'characteristic' for 28. Items 4, 6, 10, 18, and 24 also had poor item discriminations or lack of fit with the Rasch model at posttest. Items 4 and 10 were blood pressure related, 6 was nutrition related, 18 was stress management related, and 24 was exercise. In total, 9 items were removed for the remaining analyses (4, 6, 7, 10, 12, 14, 18, 24, and 28), leaving 25 items. Cronbach's alpha for the scores obtained from these 25 items was .66 and .77 at pretest and posttest, respectively. The internal consistency at posttest was comparable to the CATCH dietary knowledge questionnaire (Edmundson et al., 1996) and slightly lower than the Know Your Body Questionnaire (Williams et al., 1980).

Demographic differences in health knowledge

Differences in level of health knowledge (i.e., analyses with the health knowledge latent variable) based on parental education, gender, race/ethnicity, and family history of high blood pressure were evident at pretest. As expected, an increase in years of schooling for the parents was associated with an increase in health knowledge among the adolescents. Previous studies suggest that parental health knowledge is a significant predictor of adolescent health knowledge (Nelson, Lytle, & Pasch, 2009). One could speculate that educated parents may be more informed about health risks and more likely to share this information with their adolescents.

Boys had higher level of health knowledge at pretest compared to girls. However, previous studies indicated that girls have higher nutritional (Beech et al., 1999) and heart health knowledge (Fardy, Azzollini, Magel, White, Schmitz et al., 2000) compared to boys. A literature review on differences in cardiovascular health knowledge between adult men and women suggested that the findings are mixed (Jensen & Moser, 2008). Although boys had a significantly higher level of health knowledge at pretest, there were no significant differences in level of health knowledge at posttest between boys and girls, supporting the effectiveness of the intervention in terms of increasing health knowledge across gender. Furthermore, both boys and girls had significant improvement in mean health knowledge scores from pretest to posttest.

Racial ethnic/differences in level of health knowledge were consistent with previous findings (Beech et al., 1999; Lynch et al., 2006), and indicated that White adolescents had a higher level of health knowledge than Black and Hispanic adolescents. These differences may be related to racial/ethnic differences in socioeconomic status (SES), such as quality of education available in the schools. Previous literature suggests that low SES during adolescence is associated with poorer diets and less physical activity (Hanson & Chen, 2007), which consequently may be related to lack of knowledge and access. Although Blacks and Hispanics still had a lower level of health knowledge compared to Whites at posttest, the differences were no longer significant at posttest. Furthermore, each racial/ethnic group had similar increases in mean health knowledge score from pretest to posttest.

The 64% of adolescents who endorsed a family history of high blood pressure had a significantly higher level of health knowledge at pretest than adolescents who did not have a family history of high blood pressure. These findings suggested that adolescents with a parent or grandparent living with high blood pressure were probably already exposed to information about some of the risk factors and treatment for cardiovascular disease. There was no significant difference in level of health knowledge between those with a family history of high blood pressure and those without at posttest. Furthermore, there was a significant increase in mean health knowledge score from pretest to posttest for both groups, again suggesting the effectiveness of the intervention.

Treatment effects on health knowledge score: Improvements in mean health knowledge score within treatment conditions from pretest to posttest

There was a significant increase in mean health knowledge score from pretest to posttest across the treatment conditions. However, the moderate and intense conditions had a larger increase compared to the minimal, which may be related to the large percentage (90% – 94%) of information participants in the moderate and intense conditions were exposed to given the group sessions and opportunity to make-up missed sessions. The effect sizes for the change in health knowledge from pretest to posttest for each treatment condition were comparable to previous studies. For instance, the small effect size for the change in knowledge for the minimal condition (a significant increase of 1.17 points from baseline to post-intervention three months after randomization) was comparable to the small effect size found for the FAST Program (Miller et al., 2007) intervention group, which assessed change in health knowledge from baseline to long-term posttest (i.e., 8-weeks after 50 minute presentation). The small effect size for the change in health knowledge from pretest to posttest for the minimal condition suggests that the single 90-minute session was not enough to make a clinically significant impact on adolescent health knowledge. Furthermore, the minimal condition required that the participants read the information in the workbook on their own, which may not be a realistic requirement for adolescents.

The large effect sizes for the change in health knowledge for the moderate (baseline to three months post randomization) and intense (baseline to six months post randomization) conditions were comparable to the large effect size for change in health knowledge from baseline to post-intervention (i.e., 16 weeks after baseline) for the intervention group in the Harrell et al. (2005) study. Findings indicate that cardiovascular lifestyle interventions provided in a group setting over the course of several months were effective in terms of increasing health knowledge in adolescents. Furthermore, previous studies to improve cardiovascular health knowledge have been school-based, but findings from the current study suggest the possibility of implementing an intervention that involves recruitment from the schools, but can be administered in a community setting.

Treatment effects on level of health knowledge: Differences among treatment conditions at pretest and posttest

Previously reviewed studies assessed treatment effects by comparing health knowledge scores at pretest to posttest for the intervention group or comparing the deltas or change scores from the intervention and control groups. However, examining treatment effects in this manner involves using observed scores, which consist of the true score plus error. In the current study, structural equation modeling was used to create a health knowledge latent variable thus separating true score from error. Furthermore, the difficulty of each item at posttest was fixed to those at pretest so that not only was measurement error controlled in the analyses, but also item difficulty. Using this method allowed a more reliable test of treatment effects on the level of health knowledge at pretest and posttest. There were no significant differences in level of health knowledge among the treatment conditions at pretest, which suggested that randomization was successful. Given the same level of item difficulty at pretest, findings at posttest suggested adolescents in the intense condition had a significantly higher level of health knowledge than adolescents in the minimal and moderate conditions. Also, the moderate condition had a significantly higher level of health knowledge than the minimal.

The large effect size for difference in level of health knowledge at posttest between the intense and minimal condition was comparable to the large effect size found in the Harrell et al. (2005) study comparing the intervention to the control group (a school that only received baseline and post testing) at posttest. The medium effect size for the difference in level of health knowledge for the moderate condition compared to the minimal condition at posttest was comparable to the medium effect size reported for the intervention group compared to the control (students that only attended regular physical education volleyball classes) in the PATH program (Fardy et al., 1996) at posttest. Given that both the intense and moderate conditions consisted of the same group sessions, perhaps the length of the intense condition and the six individual sessions helped adolescents to learn and retain more intervention material. Individual sessions were focused on specific problem areas for the adolescent (e.g., high cholesterol or lack of activity) and allowed time to cover more information in detail, perhaps giving intense condition participants an advantage on the Health Knowledge Assessment.

Cardiovascular health interventions for youth and health behavior changes

There was no significant change in sodium, sugar, or fiber intake as well as kilocalories expended per day or peak VO_2 over the course of six months (i.e., time 1, 2, and 3) or baseline compared to post-intervention (i.e., three or six months post-randomization). Although there was a significant decrease in saturated fat, there was no variance in the slope to be modeled. These findings suggested that the intervention did not lead to any significant health behavior changes. There are mixed findings in the literature regarding the impact of cardiovascular health interventions on changes in health behaviors in adolescents. In the PATH Program (Fardy et al., 1996), girls that were in the intervention group had significant improvements in dietary score (measured by a food frequency checklist of 31 common foods high in cholesterol, saturated fat, salt, or sugar) and VO_{2max} after the 11-week intervention; however, there were no significant changes in diet or fitness for boys in the intervention group. In a school-based intervention to improve heart health for third and fourth graders with multiple CVD risk factors (Harrell, Gansky, McMurray, Bangdiwala, Frauman et al., 1998) the two intervention groups had significant improvements in physical activity scores (as calculated by the Know Your Body Health Habits Survey) after the 8-week intervention, but there was no change in how often they consumed fatty foods (measured by a questionnaire consisting of a short list of high and low fat foods that required participants to circle how often they consumed each). In the Harrell et al. (2005) study there was no improvement in saturated fat, sodium, or dietary fiber intake for the intervention group, which was measured by a 24-hour dietary recall administered at baseline and 16 weeks later. Because there was a lack of change in diet and physical activity in the current study, the original research objective could not be addressed (i.e., does level of health knowledge predict change in health behaviors) and instead the association between level of health knowledge and health behavior at post-intervention was tested.

Relationship between health knowledge and health behavior outcomes in adolescents

Level of nutrition knowledge at posttest was not associated with saturated fat, sodium, sugar, or fiber intake at post-intervention controlling for gender, parent education, and treatment condition. Also, level of exercise knowledge at posttest was not associated with kilocalories expended per day or peak VO_2 at post-intervention. These findings are consistent with the Smalley et al. (2004) study, which suggested that even though adolescents had knowledge of CVD risk factors they were still engaging in unhealthy behaviors. Although it is possible for one to have knowledge of how to be healthy and yet choose to engage in unhealthy behaviors, the lack of association between health knowledge and health behavior in the current study may be more related to issues with the measures used to quantify health behaviors. A 24-hour dietary recall was used to obtain information about dietary intake in the current study. In a previous study a significant association between nutrition knowledge (measured by 8 items that assessed knowledge of nutrients in certain foods) and food variety score (i.e., the number of different foods from a list of 30 food items consumed in the past week) was found among adolescents (Gracey et al., 1996). Perhaps nutrition knowledge is more related to the frequency and type of foods (high fat, low fat, fruit, or vegetable) consumed rather than the actual amount of the macronutrient (i.e., sodium, saturated fat, sugar, or fiber). Furthermore, exercise knowledge may better predict the frequency of exercise rather than the physiological outcomes such as calories expended or improvement in cardiorespiratory fitness. For example, despite a small correlation, findings from a recent study with adolescents suggested that physical activity knowledge was significantly associated with an increase in moderate physical activity (measured by a question that assessed how many times in the past 14 days an adolescent engaged in light exercise) and less television viewing (Nelson et al., 2009). Type and frequency of foods eaten as well as frequency of exercise can be obtained from a 24-hour dietary recall and 7 Day Activity Recall, respectively, but this information was not available to be analyzed in the current study.

Level of nutrition knowledge at posttest was marginally associated with nutrition self-efficacy at posttest suggesting that as knowledge increased, confidence to consume a healthy diet also increased. These findings are well supported in previous literature including the CATCH study (Edmundson et al, 1996) and the Long and Stevens (2004) study, which indicated that self-efficacy for consuming lower fat and lower sodium foods was significantly associated with dietary knowledge of lower fat and lower sodium foods. On the other hand, level of nutrition knowledge was not associated with nutrition readiness for change. These findings suggest that although adolescents increased their health knowledge, they were still not ready to make nutrition related changes. According to the means in Table 3, across the treatment conditions, adolescents were between contemplating and preparing to reduce fatty food intake, but were not quite active in making any changes. Perhaps there were some barriers (e.g., family, peers, neighborhood, financial) not assessed in the current study that may have made it difficult for adolescents to act upon or apply their newly gained health knowledge.

Role of self-efficacy and readiness for change in health behaviors

Nutrition self-efficacy at post-intervention was not associated with saturated fat, sodium, or fiber intake at post-intervention. However, a 1-point increase in nutrition self-efficacy was associated with a 10 gram decrease in sugar intake at post-intervention. These findings are consistent with a recent study that found a significant, negative correlation between self-efficacy to reduce intake of foods with low nutritional value (i.e., salty snacks, fast foods, high calorie drinks, refined baked goods, and sweets) and actual intake of foods with low nutritional value (Strachan & Brawley, 2009). Although the nutrition readiness for change item was focused on the adolescent's readiness to avoid fatty foods, there was no significant association with saturated fat intake at post-intervention. These findings are surprising given that previous studies have found a significant association between nutrition stage of change and dietary fat intake (Greene & Rossi, 1998; Finckenor & Byrd-Bredbenner, 2000). Perhaps the difference in findings is related to the instruments used to measure dietary fat intake (food frequency questionnaire) and stage of change (stages of change algorithm) in the previous studies. However, a 1-point increase in nutrition readiness for change was associated with a 20 gram decrease in sugar intake at post-intervention. Perhaps adolescents reduced their consumption of refined baked goods (e.g., cookies, donuts), which are high in sugar as well as fat.

A recent review suggested that self-efficacy played a mediating role in physical activity among children and adolescents (Lubans, Foster, & Biddle, 2008); however, in the current study there were no significant associations between exercise self-efficacy and exercise knowledge, peak VO_2, or kilocalories expended per day at post-intervention. The lack of findings may be related to the low variability given that there were only two exercise self-efficacy items. Furthermore, the two items had low internal consistency. On the Self-efficacy Questionnaire, the first exercise item asked how certain the participant was about walking every other day for 20 minutes whereas the second item asked about confidence to regularly exercise. The first item was more specific and could be operationalized. Although the second item is more general and allows one to highly endorse it if they are engaging in other activities besides walking, the definition of "regularly exercising" could be subjective and thus harder to confirm with outcome data. Similarly, there were no significant relationships between exercise readiness for change and exercise knowledge, kilocalories expended per day or peak VO_2 at post-intervention. Adolescents, on average, endorsed being in the preparation stage at pretest across treatment conditions and while the minimal condition stayed in the preparation stage, the moderate and intense conditions, on average, moved into the action stage at posttest. The action stage of change for exercise item states, "I currently exercise regularly, but I have only begun doing so within the last 6 months." Despite the endorsement of regularly exercising, the lack of association with physical activity and cardiorespiratory fitness suggest that either the adolescents were misreporting on the readiness for change measure and/or activity recall or they had not been engaging in exercise long enough to make a physiological impact such as improving peak VO_2.

Treatment effects on psychosocial variables

Although not a major focus of the analyses, it should be noted that at posttest the intense condition had higher nutrition self-efficacy, nutrition readiness for change, and exercise readiness for change compared to the minimal condition and higher nutrition readiness for change than the moderate condition. Despite having no impact on dietary and physical activity outcomes, it is clear that the intervention, specifically the intense condition was instrumental in terms of increasing adolescents' self-efficacy and readiness to improve health behaviors.

Limitations

Limitations of the current study warrant attention. Psychometric analyses of the Health Knowledge Assessment were limited to applying a Rasch model because of the small sample size. The Rasch model only estimates item difficulty and assumes that each item has the same discrimination (i.e., equal to 1). By not estimating item discriminations, there was no way to distinguish high scorers from low scorers in the analyses for Objectives 2 and 3. Also, the Rasch model does not account for guessing, which is likely to occur in a multiple choice test.

A strength and a limitation of the current study included using the amount of macronutrients consumed as a measure of dietary intake as well as using kilocalories expended per day and peak VO_2 as measures of physical activity. However, these types of measures could be considered outcomes of nutrition and exercise behaviors rather than the actual behaviors. Future studies should examine the association between level of health knowledge based on the Health Knowledge Assessment and the type and frequency of certain foods consumed as well as the frequency of physical activity.

Dietary intake was only assessed every three months and consisted of an average intake of two non-consecutive days. Perhaps measurement of dietary intake could have been improved by obtaining the type and frequency of foods eaten as in previous studies (Fardy et al., 1996; Gracey et al., 1996) or measuring dietary intake over the course of one week rather than just a single 24-hour recall. Although adolescents were provided with the definition and examples of moderate, hard, and very hard intense activities, adolescents may have still misreported the amount or intensity of any activities engaged in during the week on the 7 Day Activity Recall given that they had to think back over the course of the previous week. Perhaps adolescents should have been required to keep a physical activity log or wear an accelerometer to record actual activity for the week prior to their follow-up appointment.

Also, questionnaires used to measure self-efficacy and readiness for change could perhaps be revised to improve measurement of these psychosocial constructs. There were only two exercise self-efficacy items and they had low internal consistency. Additional and more detailed items that assess efficacy to decide when, where, and how to engage or increase physical activity would be informative. Furthermore, to meet criteria for the action and maintenance stages of change for avoiding fatty foods and engaging in regular exercise, adolescents had to be making these changes within the last six months (action) or longer than six months (maintenance). However, post-intervention for the minimal and moderate conditions occurred at three months post randomization, which actually made it hard for them to endorse the action stage and impossible for them to endorse maintenance unless they had previously endorsed the action stage. Given that the definitions of action and maintenance cannot be altered, the length of future interventions and follow-up periods should coincide with the appropriate timing for stages of change (e.g., 6 months or longer for maintenance) in order to ensure that valid information is being obtained.

Implications

Implications of this study suggest that a cardiovascular health intervention for adolescents with elevated blood pressure, specifically consisting of group sessions and/or individual sessions over the course of three to six months, was effective in terms of increasing cardiovascular health knowledge across sex and racial/ethnic groups. The intervention also resulted in increased nutrition and exercise related self-efficacy and readiness for change.

The KAB model as described in Baranowski et al. (2003) was not tested due to the lack of change in dietary and physical activity overtime; however, the association between level of health knowledge and health behaviors was examined. When examining the association between health knowledge and health behaviors cross-sectionally, level of health knowledge was not associated with dietary intake or physical fitness as hypothesized. These findings raise more questions rather than doubt about the role knowledge plays in health behavior change. For instance, questions still remain about how researchers should conceptualize health knowledge. Based on the internal structure of the nutrition related items on the Health Knowledge Assessment, items that assessed knowledge of food groups, serving sizes, health risks of a poor diet, substances to decrease in the diet, food labels, and caloric intake were a good measure of the nutrition knowledge construct. Similarly, items that assessed knowledge of the definition of aerobic exercise, benefits of regular exercise, how much exercise to do, examples of aerobic exercise, and heart rate were a good measure of the exercise knowledge construct. However, an increase in cardiovascular health knowledge does not indicate that the individual has knowledge of how to apply this new information in their daily life. Previous literature suggest that health knowledge should not only be conceptualized as the ability to retain or respond to questions based on factual information, but also as a measure of behavioral capability (Vega et al., 1987) and a step in the decision-making process to make a health behavior change (Baranowski et al., 2003). For instance, the Health Knowledge Assessment could be improved by including items that assess knowledge of how to access and prepare healthy foods, how to increase physical activity, and where to do activity despite environmental barriers.

This study also raised questions about how best to measure dietary intake and physical activity. In the current study, measures of dietary intake and physical activity consisted of health behavior outcomes rather than the actual eating and exercise behaviors. Future studies should not only examine the association between health knowledge and type and frequency of foods consumed and frequency of exercise, but perhaps test the actual behaviors as mediators of change in health outcomes (i.e., macronutrient intake, kilocalories expended or cardiorespiratory fitness).

Despite the non-significant association between nutrition knowledge and any of the dietary variables, the moderate association between nutrition knowledge and nutrition self-efficacy as well as the significant association between sugar intake and nutrition self-efficacy, suggest an indirect mechanism for health behavior change. In other words, as nutrition knowledge increases, confidence in the ability to eat a healthy diet also increases, which results in improved health behaviors and thus health outcomes (i.e., decrease in sugar intake). However, we can only assume this is the mechanism based on findings from the current study, but it is clear more reliable measures/items for health knowledge, diet, exercise, self-efficacy, and readiness for change need to be developed before the process of making health behavior changes can be confirmed.

In conclusion, the cardiovascular health knowledge test developed for Project ACE was found to be a reliable measure of health knowledge in an adolescent sample. Furthermore, the cardiovascular lifestyle intervention for adolescents with elevated blood pressure resulted in improvement in health knowledge at posttest as well as self-efficacy and readiness for change. Clinically, the findings from the current study suggest that not only is it important to continue to provide health education for adolescents, but teaching health related facts and skills in a group setting, more than once, may be more effective. Also, health education provided within clinic or community settings should also incorporate skill building to improve self-efficacy and increase readiness for change that will eventually lead to health behavior changes. Finally, the effectiveness of this intervention, which involved recruitment from local high schools, but was conducted in a community setting, suggest that components of Project ACE can be disseminated to community centers or clinics to aid in the improvement of adolescent cardiovascular health knowledge.

References

Allport, G. (1935). Attitudes. In C. Murchinson (Ed.), *A handbook of social psychology* (pp. 798-844). Worcester, MA: Clark University Press.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Baranowski, T., Cullen, K.W., Nicklas, T., Thompson, D., & Baranowski, J. (2003). Are current health behavioral change models helpful in guiding prevention of weight gain efforts? *Obesity Research*, 11 (Supplement), 23S – 43S.

Beech, B.M., Rice, R., Myers, L., Johnson, C., & Nicklas, T.A. (1999). Knowledge, attitudes, and practices related to fruit and vegetable, consumption of high school students. *Journal of Adolescent Health*, 24, 244-250.

Cohen, J.E., Pederson, L.L., Ashley, M.J., Bull, S.B., Ferrence, R., & Poland, B.D. (2002). Is 'stage of change' related to knowledge of health effects and support for tobacco control? *Addictive Behaviors*, 27, 49-61.

Collins, K.M., Dantico, M., Shearer, N.B.C., & Mossman, K.L. (2004). Heart disease awareness among college students. *Journal of Community Health*, 29 (5), 405-420.

Crespo, C.J., Smit, E., Troiano, R.P., Bartlett, S.J., Macera, C.A., & Andersen, R.E. (2001). Television watching, energy intake, and obesity in US children: Results from the Third National Health and Nutrition Examination Survey, 1988-1994. *Archives of Pediatric Adolescent Medicine*, 155, 360-365.

Din-Dzietham, R., Liu, Y., Bielo, M.V., & Shamsa, F. (2007). High blood pressure trends in children and adolescents in national surveys, 1963 to 2002. *Circulation*, 116, 1488-1496.

Edmundson, E., Parcel, G.S., Feldman, H.A., Elder, J., Perry, C.L., Johnson, C.C., et al. (1996). The effects of the Child and Adolescent Trial for Cardiovascular Health upon psychosocial determinants of diet and physical activity behavior. *Preventive Medicine*, 25, 442-454.

Embretson, S.E. & Reise, S.P. (2000). *Item Response Theory for Psychologists*. Mahwah, New Jersey: Lawrence Erlbaum Associates.

Ernst, N. & Obarzanek, E. (1994). Child health and nutrition: Obesity and high blood cholesterol. *Preventive Medicine*, 23, 427-436.

Falciglia, G.A., Troyer, A.G., & Couch, S.C. (2004). Dietary variety increases as a function of time and influences diet quality in children. *Journal of Nutrition Education & Behavior*, 36, 77-83.

Fardy, P.S., Azzollini, A., Magel, J.R., White, R.E.C., Schmitz, M.K., Agin, D., et al. (2000). Gender and ethnic differences in health behaviors and risk factors for coronary disease among urban teenagers: The PATH Program. *The Journal of Gender-Specific Medicine*, 3 (2), 59-68.

Fardy, P.S., White, R.E.C., Haltiwanger-Schmitz, K., Magel, J.R., McDermott, K.J., Clark, L.T., et al. (1996). Coronary disease risk factor reduction and behavior modification in minority adolescents: The PATH Program. *Journal of Adolescent Health*, 18, 247-253.

Finckenor, M. & Byrd-Bredbenner, C. (2000). Nutrition intervention group program based on preaction-stage-oriented change processes of the Transtheoretical Model promotes long-term reduction in dietary fat intake. *Journal of the American Dietetic Association*, 100, 335-342.

Frost, R. (1992). Cardiovascular risk modification in the college student: Knowledge, attitudes, and behaviors. *Journal of General Internal Medicine*, 7, 317-320.

Gracey, D., Stanley, N., Burke, V., Corti, B., & Beilin, L.J. (1996). Nutritional knowledge, beliefs, and behaviours in teenage school students. *Health Education Research: Theory & Practice*, 11 (2), 187-204.

Greene, G.W. & Rossi, S.R. (1998). Stages of change for reducing dietary fat intake over 18 months. *Journal of the American Dietetic Association*, 98, 529-534.

Hambleton, R.K. & Jones, R.W. (1993). Comparison of classical test theory and item response theory and their applications to test development. *Educational Measurement: Issues and Practices*, 12, 38-47.

Hanson, M.D. & Chen, E. (2007). Socioeconomic status and health behaviors in adolescence: A review of the literature. *Journal of Behavioral Medicine*, 30, 263-285.

Harrell, J.S., Gansky, S.A., McMurray, R.G., Bangdiwala, S.I., Frauman, A.C., & Bradley, C.B. (1998). School-based interventions improve heart health in children with multiple cardiovascular disease risk factors. *Pediatrics*, 102, 371-380.

Harrell, T.K., Davy, B.M., Stewart, J.L., & King, D.S. (2005). Effectiveness of a school-based intervention to increase health knowledge of cardiovascular disease risk factors among rural Mississippi middle school children. *Southern Medical Journal*, 98 (12), 1173-1180.

Hills, A.P., King, N.A., & Armstrong, T.P. (2007). The contribution of physical activity and sedentary behaviours to the growth and development of children and adolescents: Implications for overweight and obesity. *Sports Medicine*, 37 (6), 533-545.

Homko, C.J., Santamore, W.P., Zamora, L., Shirk, G., Gaughan, J., Cross, R., et al. (2008). Cardiovascular disease knowledge and risk perception among underserved individuals at increased risk of cardiovascular disease. *Journal of Cardiovascular Nursing*, 23 (4), 332-337.

Jensen, L.A. & Moser, D.K. (2008). Gender differences in knowledge, attitudes, and beliefs about heart disease. *The Nursing Clinics of North America*, 43 (1), 77-104.

Kanani, P.M. & Sperling, M.A. (2002). Hyperlipidemia in adolescents. *Adolescent Medicine*, 13 (1), 37-52.

Lee, C. (1993). Attitudes, knowledge, and stages of change: A survey of exercise patterns in older Australian Women. *Health Psychology*, 12 (6), 476-480.

Long, J.D. & Stevens, K.R. (2004). Using technology to promote self-efficacy for healthy eating in adolescents. *Journal of Nursing Scholarship*, 36 (2), 134-139.

Lubans, D.R., Foster, C., & Biddle, S.J.H. (2008). A review of mediators of behaviors in interventions to promote physical activity among children and adolescents. *Preventive Medicine*, 47, 463-470.

Lynch, E.B., Liu, K., Kiefe, C.I., & Greenland, P. (2006). Cardiovascular disease risk factor knowledge in young adults and 10-year change in risk factors: The Coronary Artery Risk Development in Young Adults (CARDIA) Study. *American Journal of Epidemiology*, 164 (12), 1171-1179.

Marcus, B.H., Selby, V.C., Niaura, R.S., & Rossi, J.S. (1992). Self-efficacy and the stages of exercise behavior change. *Research Quarterly for Exercise and Sport*, 63 (1), 60-66.

McNiece, K.L., Poffenbarger, T.S., Turner, J.L., Franco, K.D., Sorof, J.M., & Portman, R.J. (2007). Prevalence of hypertension and pre-hypertension among adolescents. *The Journal of Pediatrics*, 150, 640-644.

Mikkila, V. Rasanen, L., Raitakari, O.T., Marniemi, J., Pietinen, P., & Ronnemaa, T. (2007). Major dietary patterns and cardiovascular risk factors from childhood to adulthood. The Cardiovascular Risk in Young Finns Study. *British Journal of Nutrition*, 98, 218-225.

Miller, E.T., King, K.A., & Kleindorfer, D. (2007). FAST Stroke Prevention Educational Program for middle school students: Pilot study results. *Journal of Neuroscience Nursing*, 39 (4), 236-242.

Moreno, L.A. & Rodriguez, G. (2007). Dietary risk factors for development of childhood obesity. *Current Opinion in Clinical Nutrition and Metabolic Care*, 10 (3), 336-341.

Muthén, L.K. & Muthén, B.O. (1998-2002). *Mplus User's Guide*. Los Angeles: Muthén & Muthén.

Nader, P.R., Sellers, D.E., Johnson, C.C., Perry, C.L., Stone, E.J., Cook, K.C., et al. (1996). The effect of adult participation in a school-based family intervention to improve children's diet and physical activity: The Child and Adolescent Trial for Cardiovascular Health. *Preventive Medicine*, 25, 455-464.

Nelson, M.C., Lytle, L.A., & Pasch, K.E. (2009). Improving literacy about energy-related issues: The need for a better understanding of the concepts behind energy intake and expenditure among adolescents and their parents. *Journal of the American Dietetic Association*, 109, 281-287.

Ogden, C.L., Carroll, M.D., Curtin, L.R., McDowell, M.A., Tabak, C.J., & Flegal, K.M. (2006). Prevalence of overweight and obesity in the United States, 1999-2004. *JAMA*, 295 (13), 1549-1555.

Orio, F., Palomba, S., Cascella, T., Savastano, S., Lombardi, G., & Colao, A. (2007). Cardiovascular complications of obesity in adolescents. *Journal of Endocrinology Investigation*, 30, 70-80.

Pate, R.R., Wang, C.Y., Dowda, M., Farrell, S.W., & O'Neill, J.R. (2006). Cardiorespiratory fitness levels among US youth 12 to 19 years of age: Findings from the 1999-2002 National Health and Nutrition Examination Survey. *Archives of Pediatric Adolescent Medicine*, 160, 1005-1012.

Potvin, L., Richard, L., & Edwards, A.C. (2000). Knowledge of cardiovascular disease risk factors among the Canadian population: relationships with indicators of socioeconomic status. *Canadian Medical Association Journal*, 162 (9 Supplement), S5-S11.

Prochaska, J.O. & DiClemente, C.C. (1983). Stages and processes of self-change in smoking: Towards an integrative model of change. *Journal of Consulting and Clinical Psychology*, 51, 390-395.

Prochaska, J.O. & DiClemente, C.C. (1984). *The Transtheoretical Approach: Crossing Traditional Boundaries of Change.* Homewood, IL: Dow Jones/ Irwin.

Rimal, R.N. (2000). Closing the knowledge-behavior gap in health promotion: The mediating role of self-efficacy. *Health Communication*, 12 (3), 219-237.

Sallis, J.F., Haskell, W.L., Wood, P.D., Fortmann, S.P., Rogers, T., Blair, S.N., et al. (1985). Physical activity assessment methodology in the Five-City Project. *American Journal of Epidemiology*, 121 (1), 91-106.

Smalley, S.E., Wittler, R.R., & Oliverson, R.H. (2004). Adolescent assessment of cardiovascular heart disease risk factor attitudes and habits. *Journal of Adolescent Health*, 35, 374-379.

Strachan, S.M. & Brawley, L.R. (2009). Healthy-eater identity and self-efficacy predict healthy eating behavior: A prospective view. *Journal of Health Psychology*, 14, 684-695.

Torrance, B., McGuire, K.A., Lewanczuk, R., & McGavock, J. (2007). Overweight, physical activity and high blood pressure in children: A review of the literature. *Vascular Health and Risk Management*, 3 (1), 139-149.

Vanhecke, T.E., Miller, W.M., Franklin, B.A., Weber, J.E., & McCullough, P.A. (2006). Awareness, knowledge, and perception of heart disease among adolescents. *European Journal of Cardiovascular Prevention and Rehabilitation*, 13, 718-723.

Vega, W.A., Sallis, J.F., Patterson, T., Rupp, J., Atkins, C., & Nader, P.R. (1987). Assessing knowledge of cardiovascular health-related diet and exercise behaviors in Anglo- and Mexican-Americans. *Preventive Medicine*, 16, 696-709.

Williams, C.L., Carter, B.J., & Eng, A. (1980). The “Know Your Body” program: A developmental approach to health education and disease prevention. *Preventive Medicine*, 9, 371-383.

Table 1

Intervention Components by Treatment Condition

	Minimal	Moderate	Condition
Baseline assessment	X	X	X
Follow-up assessments	X	X	X
Parent & Adolescent session[a]	X		
Group sessions[b]		X	X
Individual sessions[c]			X
Follow-up phone calls	X	X	X
Parent group sessions[d]		X	X

Note. Participants in each treatment condition attended a baseline assessment and follow-up assessments every three months up to one year. [a]Only the minimal condition had a 90-minute session with the parent and adolescent. [b]Moderate condition consisted of 10 group sessions over the course of three months and the intense condition consisted of 12 group sessions over the course of six months. [c]The intense condition received 6 individual sessions with three occurring before the group sessions and three interspersed throughout the group sessions towards the end. [d]Moderate condition involved two optional parent group sessions while the intense condition had six optional parent group sessions.

Table 2

Physiological and Dietary Sample Characteristics by Treatment Condition: Mean (SD)

	Minimal (n = 58)	Moderate (n = 63)	Intense (n = 46)
Baseline			
Systolic BP mmHg	126.7 (13.3)	126.3 (8.9)	124.1 (12.3)
Diastolic BP mmHg	73.8 (11.4)	77.1 (10.9)	73.5 (10.7)
Body Mass Index (kg/m^2)	31.4 (8.1)	28.5 (6.6)	29.4 (7.5)
Saturated Fat (g)	26.2 (14.6)	26.2 (12.7)	25.3 (13.4)
Sugar (g)	127.5 (72.0)	137.7 (66.5)	129.7 (62.6)
Fiber (g)	12.2 (6.7)	11.7 (7.3)	13.7 (9.7)
Sodium (mg)	3133.7 (1653.3)	3414.2 (1728.5)	3173.8 (1572.8)
Peak VO_2	35.0 (9.1)	36.6 (8.8)	36.5 (10.1)
Kilocalories per day	3536.3 (1330.9)	3104.3 (1025.6)	3170.4 (1033.2)
Post-intervention			
Saturated Fat (g)	25.1 (15.7)	25.3 (12.5)	20.3 (11.8)
Sugar (g)	99.9 (54.3)^a	131.7 (60.2)^b	127.0 (76.2)
Fiber (g)	12.7 (7.8)	12.3 (6.3)	13.5 (8.1)
Sodium (mg)	3148.2 (1967.1)	3028.7 (1300.0)	3229.1 (1702.5)
Peak VO_2 (units)	35.9 (8.9)	37.5 (8.9)	36.2 (8.5)
Kilocalories per day	3118.2 (769.3)	3062.0 (842.8)	3090.2 (898.3)

Note. Means with different superscripts are significantly different at $p < .05$.

Table 3

Psychosocial Sample Characteristics by Treatment Condition: Mean (SD)

	Minimal (n = 58)	Moderate (n = 63)	Intense (n = 46)
Baseline			
Nutrition self-efficacy	46.2 (8.2)	44.3 (10.5)	45.9 (9.1)
Exercise self-efficacy	16.5 (3.8)	16.4 (4.4)	16.0 (3.6)
Nutrition Readiness for Change	1.7 (.9)	1.5 (.8)	1.7 (.7)
Exercise Readiness for Change	2.5 (1.1)	2.4 (1.2)	2.5 (1.1)
Post-intervention			
Nutrition self-efficacy	45.0 (9.1)^{a}	47.9 (9.9)	49.8 (6.6)^{b}
Exercise self-efficacy	15.7 (3.8)	16.5 (3.4)	16.9 (2.7)
Nutrition Readiness for Change	1.9 (.9)^{a}	1.9 (.6)^{a}	2.5 (.8)^{b}
Exercise Readiness for Change	2.5 (.9)^{a}	3.1 (.9)^{b}	3.5 (.7)^{b}

Note. Means with different superscripts are significantly different at $p < .05$.

Table 4

Health Knowledge Assessment Psychometric Properties using Classical Test Theory

	Pretest			Posttest		
Item	Mean	Standard Deviation	Corrected item-total correlation	Mean	Standard Deviation	Corrected item-total correlation
1	.47	.50	.34	.67	.47	.34
2	.80	.40	.05	.83	.37	.26
3	.63	.48	.23	.70	.46	.32
4	.91	.29	.29	.94	.24	.10
5	.51	.50	.17	.74	.44	.33
6	.32	.47	.10	.35	.48	.15
7	.47	.50	-.08	.42	.50	.01
8	.32	.47	.15	.47	.50	.27
9	.41	.49	.23	.54	.50	.33
10	.63	.48	.04	.69	.46	.17
11	.80	.40	.39	.89	.31	.24
12	.46	.50	.04	.54	.50	.08
13	.50	.50	.41	.72	.45	.42
14	.34	.47	.12	.39	.49	.01
15	.38	.49	.34	.55	.50	.22
16	.37	.48	.14	.31	.46	.24
17	.35	.48	.31	.45	.50	.37
18	.58	.49	.19	.80	.41	.17

Table 4 cont'd.

	Pretest			Posttest		
Item	Mean	Standard Deviation	Corrected item-total correlation	Mean	Standard Deviation	Corrected item-total correlation
19	.22	.42	-.04	.35	.48	.19
20	.54	.50	.42	.55	.50	.40
21	.70	.46	.55	.84	.37	.40
22	.54	.50	.13	.65	.48	.33
23	.57	.50	.27	.80	.40	.30
24	.40	.49	.19	.51	.50	.16
25	.36	.48	.11	.64	.48	.29
26	.32	.47	.12	.35	.48	.22
27	.33	.47	.04	.41	.49	.30
28	.25	.43	-.08	.31	.46	.08
29	.23	.42	-.31	.60	.49	.22
30	.69	.47	.49	.80	.41	.32
31	.47	.50	.25	.61	.49	.22
32	.74	.44	.36	.88	.32	.36
33	.42	.50	.11	.61	.49	.20
34	.61	.49	.31	.74	.44	.27

Table 5

Health Knowledge Assessment Psychometric Properties using Confirmatory Factor Analysis

	Pretest	Posttest
Item	β (SE)	β (SE)
1	.54 (.08)***	.48 (.11)***
2	.15 (.12)	.47 (.12)***
3	.31 (.10)**	.53 (.10)***
4	.55 (.12)***	.30 (.21)
5	.37 (.09)***	.52 (.10)***
6	.18 (.10)	.22 (.13)
7	-.11 (.10)	-.01 (.12)
8	.22 (.09)*	.41 (.11)***
9	.36 (.09)***	.50 (.10)***
10	.13 (.11)	.25 (.13)*
11	.62 (.10)***	.45 (.16)**
12	.03 (.10)	.09 (.12)
13	.65 (.07)***	.64 (.09)***
14	.21 (.11)*	.03 (.12)
15	.55 (.08)***	.33 (.11)**
16	.24 (.10)*	.36 (.11)***
17	.53 (.08)***	.65 (.10)***

***$p < .001$, **$p < .01$, *$p < .05$

Table 5 cont'd.

	Pretest	Posttest
Item	β (SE)	β (SE)
18	.34 (.09)***	.30 (.14)
19	.001 (.12)	.28 (.12)*
20	.63 (.07)***	.59 (.10)***
21	.82 (.06)***	.72 (.10)***
22	.26 (.10)**	.53 (.10)***
23	.48 (.08)***	.52 (.12)***
24	.27 (.09)**	.23 (.12)
25	.18 (.10)	.44 (.10)***
26	.20 (.11)	.32 (.11)**
27	.05 (.11)	.43 (.11)***
28	-.13 (.11)	.15 (.14)
29	-.50 (.09)***	.30 (.11)**
30	.70 (.07)***	.55 (.11)***
31	.41 (.09)***	.32 (.11)**
32	.61 (.08)***	.64 (.12)***
33	.17 (.10)	.30 (.11)**
34	.43 (.09)***	.39 (.11)***

***$p < .001$, **$p < .01$, *$p < .05$

Table 6

Measurement Models for Nutrition and Exercise Knowledge at Posttest

Knowledge Domain and Items	β (SE)
Nutrition Knowledge	
Item 5	.58 (.15)***
Item 8	.48 (.14)***
Item 11	.46 (.20)*
Item 13	.55 (.13)***
Item 15	.54 (.14)***
Item 16	.50 (.13)***
Item 19	.04 (.15)
Item 31	.31 (.15)*
Exercise Knowledge	
Item 20	.52 (.16)***
Item 21	.92 (.18)***
Item 22	.51 (.16)***
Item 23	.58 (.16)***

***$p < .001$, **$p < .01$, *$p < .05$

Table 7

Weighted Mean Square Statistics (z) for Health Knowledge Assessment Items

	Pre-test		Posttest	
Item	Infit (z)	Outfit (z)	Infit (z)	Outfit (z)
1	.91 (-2.2)	.90 (-2.0)	.94 (-.8)	.90 (-.9)
2	1.08 (.8)	1.17 (1.2)	.96 (-.2)	.88 (-.5)
3	.99 (-.2)	1.00 (.0)	.95 (-.5)	.88 (-.9)
4	.94 (-.2)	.71 (-1.1)	1.01 (.1)	1.25 (.7)
5	1.02 (.4)	1.03 (.5)	.94 (-.5)	.86 (-.9)
6	1.05 (.8)	1.04 (.5)	1.06 (.8)	1.15 (1.4)
7	1.18 (4.1)	1.21 (3.6)	1.20 (3.0)	1.23 (2.5)
8	1.02 (.3)	1.00 (.1)	.98 (-.3)	.97 (-.3)
9	.97 (-.6)	.95 (-.8)	.94 (-1.0)	.92 (-1.0)
10	1.10 (1.7)	1.13 (1.9)	1.05 (.6)	1.12 (1.0)
11	.86 (-1.3)	.80 (-1.5)	.94 (-.2)	.94 (-.1)
12	1.10 (2.3)	1.10 (1.8)	1.14 (2.2)	1.21 (2.5)
13	.87 (-3.3)	.85 (-3.0)	.87 (-1.4)	.82 (-1.3)
14	1.02 (.4)	1.12 (1.5)	1.17 (2.4)	1.26 (2.5)
15	.91 (-1.9)	.89 (-1.6)	1.03 (.5)	1.04 (.5)
16	1.03 (.5)	1.03 (.4)	1.00 (.1)	.95 (-.4)
17	.92 (-1.5)	.89 (-1.3)	.91 (-1.5)	.88 (-1.5)
18	1.00 (.1)	1.01 (.1)	1.03 (.3)	1.06 (.3)

Table 7 cont'd.

	Pretest		Posttest	
Item	Infit (z)	Outfit (z)	Infit (z)	Outfit (z)
19	1.09 (.9)	1.31 (2.2)	1.05 (.6)	1.07 (.6)
20	.87 (-3.1)	.84 (-3.1)	.89 (-1.9)	.89 (-1.4)
21	.78 (-3.3)	.71 (-3.5)	.86 (-.8)	.75 (-1.0)
22	1.05 (1.1)	1.05 (1.0)	.94 (-.8)	.92 (-.7)
23	.96 (-.9)	.94 (-1.0)	.95 (-.3)	.88 (-.5)
24	1.00 (.0)	.98 (-.3)	1.07 (1.1)	1.13 (1.6)
25	1.04 (.8)	1.05 (.7)	.97 (-.3)	.96 (-.3)
26	1.02 (.4)	1.05 (.5)	1.02 (.3)	1.01 (.2)
27	1.08 (1.3)	1.14 (1.6)	.96 (-.6)	.95 (-.6)
28	1.13 (1.5)	1.24 (1.9)	1.08 (.9)	1.31 (2.3)
29	1.25 (2.5)	1.65 (4.2)	1.03 (.5)	1.01 (.1)
30	.82 (-2.8)	.77 (-2.9)	.95 (-.3)	.81 (-1.0)
31	.96 (-.9)	.95 (-.8)	1.03 (.5)	1.01 (.1)
32	.90 (-1.1)	.84 (-1.5)	.87 (-.6)	.80 (-.6)
33	1.04 (1.0)	1.08 (1.4)	1.04 (.6)	1.03 (.3)
34	.94 (-1.2)	.91 (-1.5)	.99 (.0)	.91 (-.5)

Table 8

Item Difficulties for Pre- and Post Health Knowledge Assessment

Item	Pretest Difficulty	Posttest Difficulty
1	0.10	-0.21
2	-1.52	-1.23
3	-0.63	-0.37
4	-2.55	-2.38
5	-0.08	-0.59
6	0.80	1.27
7	0.10	0.97
8	0.77	0.72
9	0.36	0.43
10	-0.63	-0.33
11	-1.52	-1.73
12	0.15	0.39
13	-0.01	-0.46
14	0.72	1.12
15	0.50	0.36
16	0.57	1.51
17	0.67	0.82
18	-0.38	-0.94
19	1.35	1.31

Table 8 cont'd.

Item	Pretest Difficulty	Posttest Difficulty
20	-0.22	0.36
21	-0.94	-1.29
22	-0.20	-0.13
23	-0.34	-0.99
24	0.43	0.54
25	0.60	-0.05
26	0.80	1.27
27	0.75	1.01
28	1.16	1.51
29	1.31	0.14
30	-0.88	-0.94
31	0.13	0.10
32	-1.19	-1.65
33	0.31	0.06
34	-0.50	-0.59

Table 9

Health Knowledge at Pretest and Posttest (25 items) by Sex, Race/Ethnicity, Parental and Family History of High Blood Pressure, and Treatment Condition: Means (SD)

	Pretest	Posttest
Sex		
Boys ***	12.83 (3.77)	15.93 (4.34)
Girls ***	10.84 (4.29)	14.94 (4.46)
Race/Ethnicity		
Hispanics***	12.42 (3.75)	15.44 (4.33)
Blacks***	11.17 (4.16)	15.09 (4.48)
Whites**	13.86 (4.00)	17.36 (4.16)
Other*	14.83 (3.38)	16.83 (4.26)
Family History of High Blood Pressure		
Yes***	12.88 (4.12)	16.09 (4.36)
No***	11.18 (3.60)	14.96 (4.36)
Treatment Condition		
Minimal*	12.28 (4.14)	13.33 (4.47)
Moderate***	11.63 (3.62)	15.74 (3.91)
Intense***	13.09 (4.25)	17.81 (3.86)

Note. There was a significant increase in mean health knowledge score across sex, racial/ethnic groups, family history, and treatment conditions. *** $p < .001$, ** $p < .01$, and * $p < .05$.

Table 10

Dietary Intake and Physical Fitness at Baseline, 3-months, and 6-months for Total Sample (N = 167): Mean (SD)

	Baseline	3-month follow-up	6-month follow-up
Saturated Fat (g)	26.0 (13.5)	24.2 (13.0)	22.8 (14.5)
Sugar (g)	131.9 (67.2)	123.2 (60.5)	129.4 (78.4)
Sodium (mg)	3251.3 (1655.8)	3306.3 (1832.7)	3359.6 (2097.6)
Fiber (g)	12.4 (7.9)	13.6 (7.8)	12.8 (8.6)
Peak VO_2	36.0 (9.3)	36.5 (9.2)	36.1 (8.6)
Kilocalories expended per day	3273.6 (1153.2)	3044.2 (833.9)	3126.6 (896.8)

Table 11

Dietary Intake for Participants that Consumed a Typical Amount of Food at Post-intervention (n = 113): Mean (SD)

	Post-intervention
Saturated Fat (g)	23.2 (12.7)
Sugar (g)	121.2 (66.1)
Sodium (mg)	3094.1 (1605.3)
Fiber (g)	12.1 (7.3)

Figure 1

Item-Person Map at Pretest

```
Participants                  Items
    2                +
                     |
                     |
                     |T
                     |
                  .  |
                     |
                     |
                  . T|  q19    q29
                     |
                  #  |  q28
                     |
    1            ##  +
                     |
              .####  |S q26    q6
               ####  |  q14    q27    q8
                    S|  q17
          .########  |  q16    q25
                     |  q15
            #######  |  q24
           .#######  |  q33    q9
                     |
          .########  |  q12    q31
                     |  q1     q7
    0      ######## M+M q13
           ########  |  q5
                     |  q22
              .####  |  q20
                     |  q23
            .######  |  q18
            .######  |  q34
                     |
            .######  |  q10    q3
                    S|
                .##  |S
                     |  q21    q30
   -1            .#  +
                     |
                ###  |  q32
                     |
                 ##  |
                    T|
                     |  q11    q2
                     |
                     |
                 .#  |T
                     |
                     |
   -2             .  +
                     |
                     |
                     |
                     |
                     |  q4
                  .  |
                     |
                     |
   -3                +
```

Note. # represents 2 participants

Figure 2

Item-Person Map at Posttest

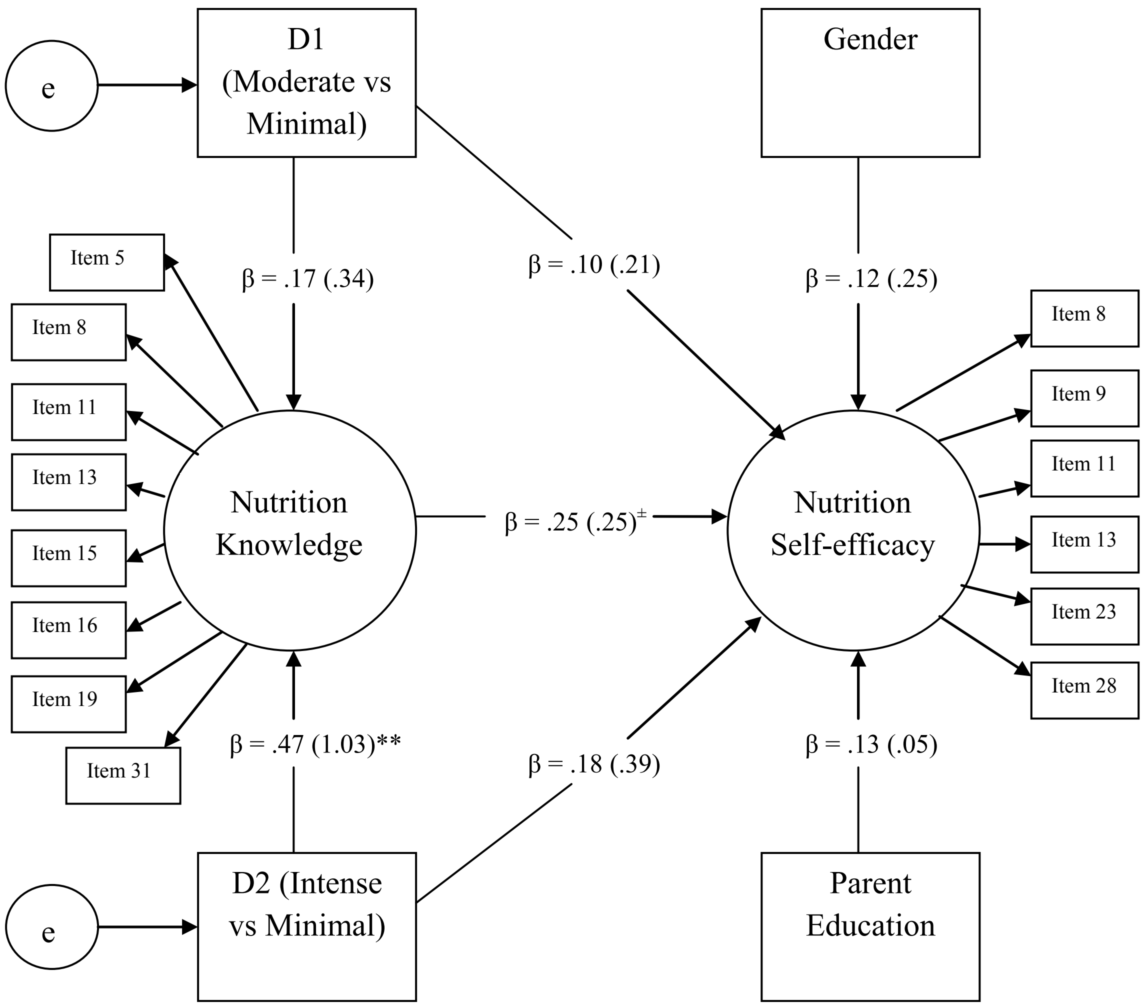
```
Participants                 Items

    4                  +
                       |
                       |
                       |
                       |
                       |
                       |
                    .  |
    3                  +
                       |
                       |
                    .  |
                       |
                    .  |
                      T|
                    .  |
    2                  +T
                 .##   |
                       |
                 .##   |
                       |  q16    q28
               .#### S|
                ####   |  q19    q26    q6
               .####   |  q14
    1                  +S q27    q7
               .####   |  q17
                .###   |  q8
                #### M|
              #######  |  q24
                       |  q12    q15    q20    q9
                ####   |
              .#####   |  q29    q31
    0             ###  +M q25    q33
                   ##  |  q22
                  ### S|  q1
                   ##  |  q10    q3
                       |  q13
                    .  |  q34    q5
                   .#  |
                    .  |
   -1               # T+S q18    q23    q30
                       |
                    .  |  q2     q21
                    .  |
                       |
                    .  |  q32
                       |  q11
                       |
   -2                  +T
                       |
                       |
                       |  q4
                       |
                       |
                       |
                       |
   -3                  +
```

Note. # represents 2 participants

Figure 3

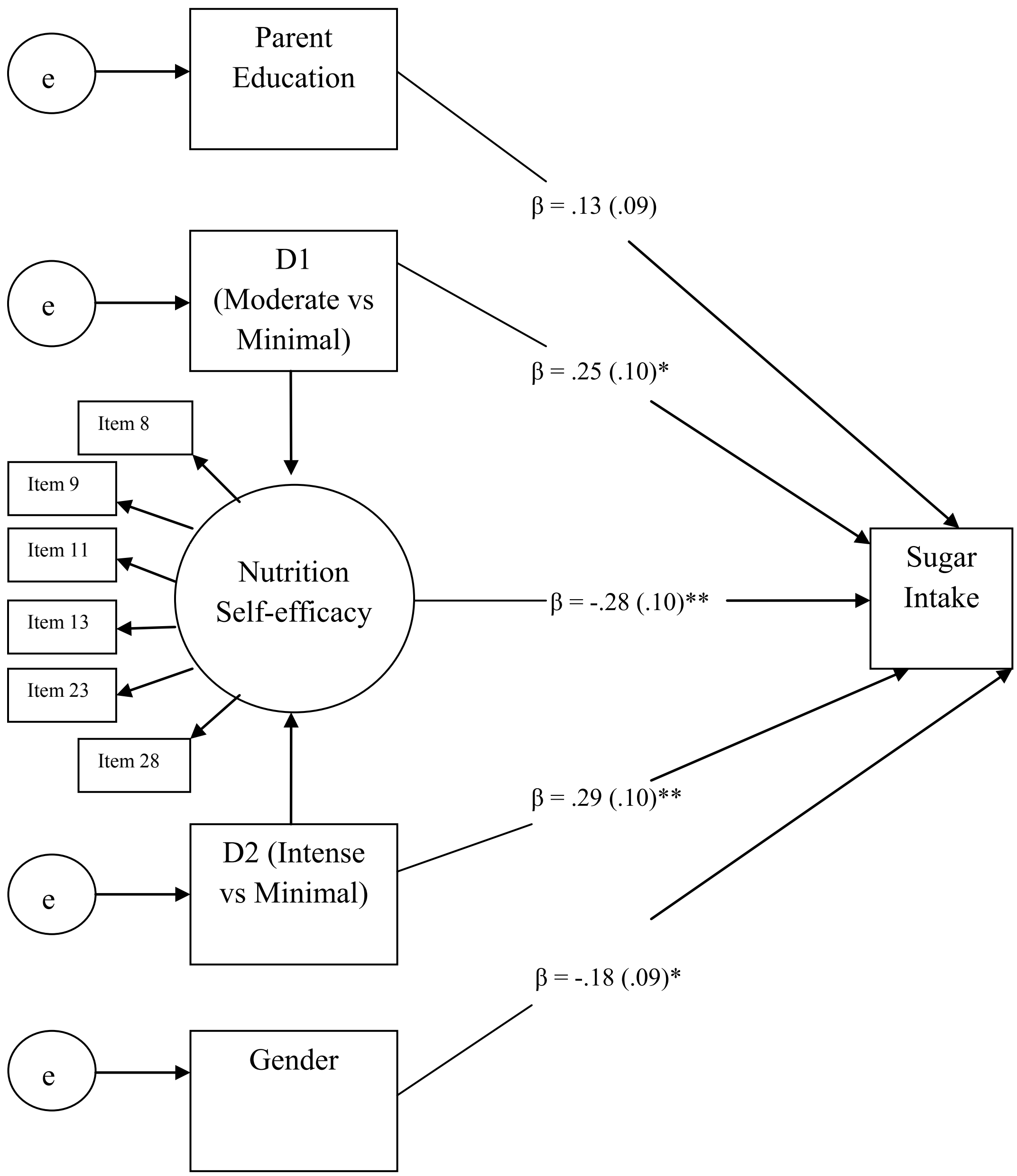
Structural Equation Model Testing the Relationship between Nutrition Knowledge and Nutrition Self-efficacy at Posttest: Standardized Coefficient (SE)



**$p < .01$, $^{\pm}p < .10$

Figure 4

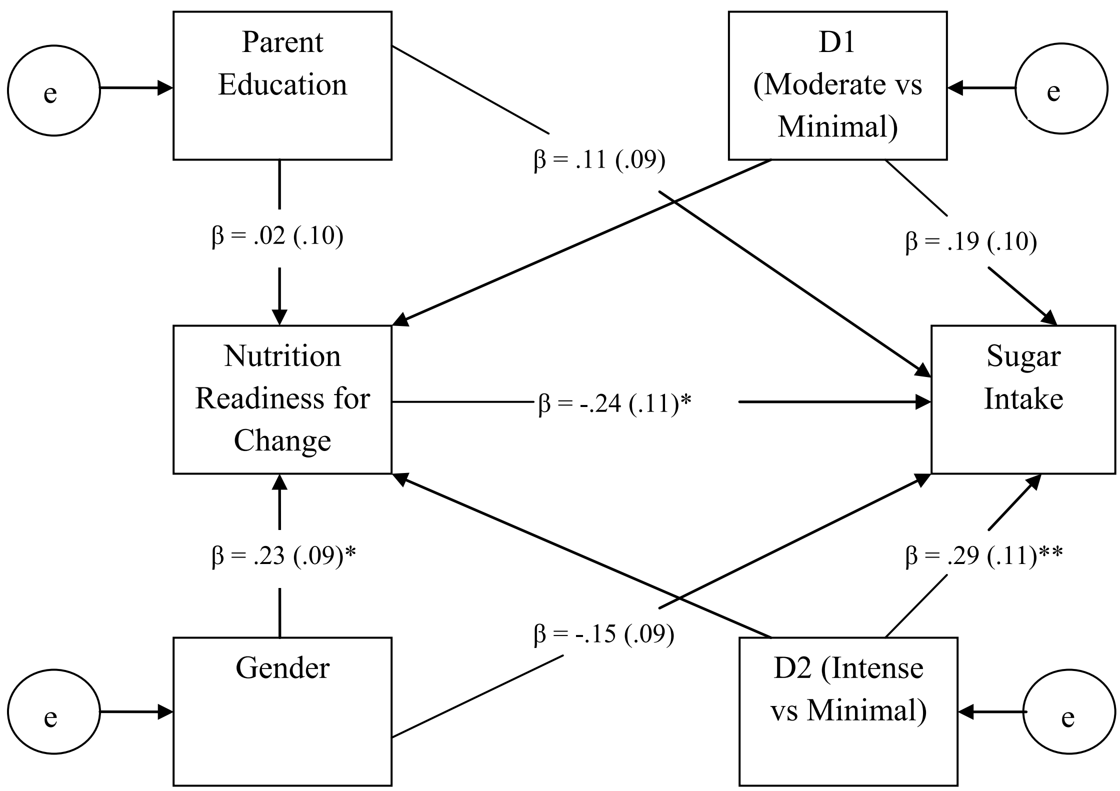
Structural Equation Model Testing the Relationship between Nutrition Self-efficacy and Sugar Intake at Post-intervention: Standardized Coefficient (SE)



***p < .001, **p < .01, *p < .05

Figure 5

Structural Equation Model Testing the Relationship between Nutrition Readiness for Change and Sugar Intake at Post-intervention: Standardized Coefficient (SE)



***p < .001, **p < .01, *p < .05

APPENDIX

HEALTH KNOWLEDGE ASSESSMENT

Please answer the following:

1. What is blood pressure?
   a) the amount of blood the heart pumps out with each beat
   b) how fast the heart beats
   c) the force of blood against the walls of the arteries of the body
   d) how long it takes the blood to circulate through the body

2. What does high blood pressure feel like?
   a) a tightness in the chest
   b) like you have just run up a flight of stairs
   c) a dull throbbing pain on the right side of your chest
   d) generally, there are no symptoms

3. Which of the following people would be LEAST likely to have high blood pressure?
   a) a white woman who teaches step aerobics
   b) a black man who teaches step aerobics
   c) a white woman who eats a diet high in salt
   d) a black man who eats a high diet in salt

4. Which of the following is NOT suggested to help high blood pressure?
   a) regular exercise
   b) medications
   c) stress reduction
   d) increase in salt consumption

5. From top to bottom, what are the groups in the food pyramid?
   a) dairy, fats and oils, grains, meat, vegetables and fruits
   b) fats, oils and sweets, meat, dairy, grains, vegetables and fruits
   c) grains/breads, dairy, vegetables and fruits, fats, oils and sweets
   d) fats, oils and sweets, dairy, meat, vegetables and fruits, grains

6. All of the following are examples of a serving EXCEPT:
   a) an 8 oz. glass of milk
   b) a bagel
   c) a medium apple
   d) a medium hamburger patty

7. Which of the following does NOT indicate the correct number of servings a day that you should eat?
   a) dairy: 2-4 servings
   b) grain/bread: 4-5 servings
   c) fruit: 2-4 servings
   d) vegetables: 3-5 servings

8. Which type of fat is solid at room temperature?
   a) saturated or hydrogenated fat
   b) polyunsaturated fat
   c) monosaturated fat
   d) all of the above

9. What is atherosclerosis?
   a) when the heart cannot pump enough blood to the body with each heart beat
   b) when the chambers in the heart are too small
   c) an irregular heart beat
   d) when the inside of the blood vessels become coated with fat

10. What is the desirable level of cholesterol to maintain for good health?
    a) less than 100
    b) less than 200
    c) less than 300
    d) less than 400

11. What does eating a large amount of saturated fat do to cholesterol levels?
    a) raise them
    b) lower them
    c) keeps them safe
    d) it depends on the particular type of food eaten

12. What minerals have a positive effect on blood pressure?
    a) calcium and zinc
    b) zinc and magnesium
    c) calcium and potassium
    d) potassium and magnesium

13. What substances should you decrease in your diet?
    a) caffeine, fiber
    b) sodium, caffeine
    c) fiber, sodium
    d) all of the above

14. How much sodium is recommended per day?
    a) Less than 2.4 grams
    b) Less than 24 grams
    c) Less than 240 grams
    d) there is no recommended amount

15. How are ingredients on the food label listed?
    a) in order of amount in a product, with the ingredient in largest quantity first, down to the smallest quantity
    b) in order of amount in a product, with the ingredient in smallest quantity first, up to the largest quantity
    c) alphabetically
    d) it depends on the brand of the food

16. What is the correct number of calories per gram of the following substances?
    a) fats=4, protein=9, carbohydrates=4
    b) fats=4, protein=4, carbohydrates=9
    c) fats=9, protein=4, carbohydrates=4
    d) fats=9, protein=9, carbohydrates=4

17. What are stressors?
    a) the physical responses that occur when a person is under stress
    b) situations and thoughts that cause stress
    c) the emotional responses that occur when a person is under stress
    d) all of the above

18. Which of the following are NOT stressful?
    a) taking an important exam
    b) a new romance
    c) the death of a relative
    d) none of the above

19. How many extra calories must you consume to gain one pound?
    a) 1000
    b) 2500
    c) 3500
    d) 4000

20. Which of the following does NOT result from regular exercise?
    a) decreases in muscle tension
    b) increase of oxygen to the brain
    c) increase in circulation
    d) increase in blood pressure

21. What is aerobic exercise?
    a) exercise that conditions the heart and lungs
    b) exercise for the purpose of increasing muscle mass
    c) exercise that makes the kidneys more efficient
    d) exercise that is done to music

22. How often should you do aerobic exercise to get its full benefits?
    a) at least 5 times a week for a minimum of 10 minutes
    b) at least 5 times a week for a minimum of 20 minutes
    c) at least 3 times a week for a minimum of 10 minutes
    d) at least 3 times a week for a minimum of 20 minutes

23. Which of the following is an example of aerobic exercise?
    a) gardening
    b) weight lifting
    c) yoga
    d) swimming

24. What should your target heart rate be during aerobic activity?
    a) 25-50% of your maximum heart rate
    b) 50-65% of your maximum heart rate
    c) 70-85% of your maximum heart rate
    d) 85-100% of your maximum heart rate

25. All of the following are forms of relaxation except?
    a) Deep Breathing
    b) PMR
    c) REM
    d) All of the above

26. What do you call the physical reaction a person's body has that prepares him/her to meet a challenging situation?
    a) alertness
    b) fight or flight response
    c) vigilance
    d) self preservation response

27. Good ways to deal with a stressful situation include all of the following EXCEPT:
    a) practice relaxation
    b) rehearse for it
    c) expect some stress
    d) try not to think about it

28. Which is NOT a characteristic of “automatic thoughts?”
    a) they are often irrational
    b) they are hard to turn off
    c) they are positive self-statements
    d) they are learned

29. Which is NOT one of the three A’s of stress management?
    a) Avoid
    b) Assess
    c) Alter
    d) Adapt

30. Problem-solving consists of all of the following steps EXCEPT:
    a) considering the consequences
    b) avoiding the problem
    c) evaluating the outcome
    d) making a decision

31. What information is NOT provided on a typical food label?
    a) number of calories per serving
    b) grams of fat
    c) number of servings required per day
    d) percentage of your daily requirement of certain vitamins and minerals

32. Physical responses to stress include all of the following EXCEPT:
    a) voice deepening
    b) increased blood pressure
    c) increased heart rate
    d) muscle tension

33. Which is the most important thing that influences how you feel in a stressful situation?
    a) what you think about the situation
    b) what the situation actually is
    c) who is with you time at the time
    d) your body’s physical condition

34. What usually triggers a relapse?
    a) something very good happening to you
    b) forgetfulness
    c) negative emotions or stressful events
    d) nobody knows what triggers a relapse

24-HOUR DIETARY ASSESSMENT

Breakfast, Lunch, & Dinner

Below list everything that you ate or drank (including water). List how much you ate and be sure to include seasonings like salt and pepper. If you know how the food was prepared, please list this information also. Did you take any **vitamins or minerals**? If, YES, please list them also.

Description of foods eaten: **Time meal eaten: ____:____ AM/PM** **Did you take any vitamins or minerals? If YES, please describe___________________________**
Morning, Afternoon, Evening Snack: **Time meal eaten: ____:____ AM/PM** **Did you take any vitamins or minerals? If YES, please describe___________________________**
COMMENTS:____

7 DAY ACTIVITY RECALL

Think back over the past 7 days. We would like to know how many hours of sleep you had and how physically active you were each day. Physical activity is a broad term. It includes playing sports, exercising, doing some job, and chores. The attached chart has examples of various types of activities. For each day, list the amount of time you slept each night. List all physical activities and how much time you spent in each activity. For example, if you jogged for 45 minutes on Monday, write “jog-45min”.

Days	Hours Slept	Activities and time spent in each activity:
SUNDAY		
MONDAY		
TUESDAY		
WEDNESDAY		
THURSDAY		
FRIDAY		
LAST SATURDAY		

Compared to your physical activity, was last week’s physical activity more, less, or about the same?

_____1. LESS 2._____ ABOUT THE SAME 3._____ MORE

DIET, EXERCISE AND STRESS MANAGEMENT QUESTIONNAIRE (DESM-SCQ)

I. Place a check in front of the statement that is most true for you:

_____a. I currently eat a lot of fatty or fried foods, and I do not intend to eat less fatty or fried foods in the next 6 months.
_____b. I currently eat a lot of fatty or fried foods, but I am thinking about starting to eat less fatty or fried foods in the next 6 months.
_____c. I eat fatty or fried foods sometimes but not regularly.
_____d. I currently eat fatty or fried foods, but I only started doing so in the last 6 months.
_____e. I do not eat fatty or fried foods and have done so for more than 6 months.

II. Place a check in front of the statement that is most true for you:

_____a. I do not eat a healthy diet, and I do not intend to start eating a healthy diet in the next 6 months.
_____b. I do not eat a healthy diet but I am thinking about starting to eat a healthy diet in the next 6 months.
_____c. I eat a healthy diet sometimes but not regularly.
_____d. I currently eat a healthy diet, but I only started doing so in the last 6 months.
_____e. I currently eat a healthy diet and have done so for more than 6 months.

III. Place a check in front of the statement that is most true for you:

_____a. I currently do not exercise, and I do not intend to start exercising in the next 6 months.
_____b. I currently do not exercise, but I am thinking about starting to exercise in the next 6 months.
_____c. I currently exercise some but not regularly.
_____d. I currently exercise regularly, but I have only begun doing so within the last 6 months.
_____e. I currently exercise regularly and have done so for longer than 6 months.

IV. Place a check in front of the statement that is most true for you:

_____a. I currently do not handle my stress effectively, and I do not plan to handle stress better in the next 6 months.
_____b. I currently do not handle my stress effectively, but I am thinking about handling stress better in the next 6 months.
_____c. I manage my stress effectively sometimes but not regularly.
_____d. I currently manage my stress effectively, but I have only begun doing so within the last 6 months.
_____e. I currently manage my stress effectively and have done so for longer than 6 months.

SELF-EFFICACY QUESTIONNAIRE

Instructions: At this point in time, how confident or certain are you that you can do the following:

Cannot do at all		Slightly certain can do			Moderately certain can do			Fairly certain can do		Completely certain can do
0	1	2	3	4	5	6	7	8	9	10

For each of the following items, write a number from 0 to 10, using the scale above.

______ 1. Relax when you need to.
______ 2. Put into practice what you learn in the Project ACE program.
______ **3. Walk 20 minutes every other day for exercise. (Exercise)**
______ 4. Solve a problem by considering the alternatives and choose the best way to cope.
______ 5. Plan how to cope with a setback.
______ 6. Practice muscle relaxation.
______ 7. Calm yourself by making rational statements to yourself.
______ **8. Improve eating habits. (Nutrition)**
______ **9. Eat fewer high fat foods. (Nutrition)**
______ 10. Recognize high-risk situations that are hard for you to cope with.
______ **11. Eat high fiber foods. (Nutrition)**
______ 12. Reduce stress.
______ **13. Make healthy food choices. (Nutrition)**
______ 14. Set appropriate goals for yourself.
______ 15. Identify situations where you feel stressed or upset.
______ 16. Practice your coping skills.
______ 17. Avoid developing bad habits like smoking.
______ 18. Plan how to cope with stress.
______ 19. Think about problems in different ways.
______ **20. Regularly exercise. (Exercise)**
______ 21. Cope with a relapse.
______ 22. Avoid developing bad habits like drinking alcohol.
______ **23. Eat when you are hungry, not when you are bored. (Nutrition)**
______ 24. Develop a healthy lifestyle.
______ 25. Cope with a difficult situation.
______ 26. Adopt a healthy lifestyle.
______ 27. Explain what high blood pressure is.
______ **28. Eat less salt. (Nutrition)**
______ 29. Keep a diary of your activities.
______ 30. Read and understand nutritional labels.