I, Allison M. Wagner, hereby submit this work as part of the requirements for the degree of:

Master of Science in:
Department of Nutritional Science in the College of Allied Health Sciences

It is entitled:
Changes in Knowledge, Self Efficacy and Diet among Adolescents with Hypertension in Response to a DASH Diet Intervention Utilizing the Social Cognitive Theory

This work and its defense approved by:

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Changes in Knowledge, Self Efficacy and Diet among Adolescents with Hypertension in Response to a DASH Diet Intervention Utilizing the Social Cognitive Theory

By
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B.A., Xavier University, 2002

Master of Science in Nutrition
Department of Nutritional Science
College of Allied Health Sciences

Committee Chair: Sarah C. Couch, Ph.D., R.D.
Abstract

Purpose. To evaluate the effectiveness of a nutrition intervention based on the Social Cognitive Theory (SCT) emphasizing fruits, vegetables, and low fat dairy products, and low fat, low sodium foods (DASH) on changing dietary knowledge, self-efficacy and intake in adolescents with hypertension. Methods. 46 adolescents with hypertension were randomly assigned to the DASH intervention (n=23) or a one time meeting with a dietician (usual care, n=23). Diet, knowledge, and self-efficacy were assessed before and after the 3 month treatment. Results. After the intervention, diet-related knowledge was greater in the DASH group versus the usual care group, and there was a trend for a greater gain in self-efficacy in the DASH group. Also, the DASH participants had a greater increase in fruits, vegetables and low-fat diary products, and a greater reduction in high fat, high sodium foods as compared to the usual care group. Conclusion. A nutrition intervention emphasizing fruits, vegetables and low-fat diary products and based on the theoretical concepts of the SCT resulted in improvements in diet quality, knowledge, and self-efficacy in adolescents with hypertension.
Acknowledgements

I would like to thank my family and friends for their continued support and encouragement over the past few years, especially my parents, whose love and support never fails. I would also like to thank my advisor, Dr. Couch, for her insight, knowledge and guidance during the completion of my thesis and my Master's degree.
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<td>Table 3</td>
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INTRODUCTION

Epidemiological data collected over the last decade show a dramatic increase in overweight and obesity among children and adolescents in the United States (1). Likely contributing factors include larger portion sizes particularly of foods eaten outside the home, greater variety of high calorie foods available in the marketplace, greater use of technology, and less overall “active time” spent during the day (2). These unhealthy lifestyle habits complement the rising rates of many chronic diseases in the U.S., such as diabetes, cardiovascular disease (CVD) and hypertension, also known as “the silent killer.” While many of these illnesses were once considered adult onset diseases, the pervasiveness of unhealthy lifestyle habits and obesity among all age groups has contributed to the presence of early chronic diseases and associated risk factors.

While pharmacological interventions have been used for the treatment of children and adolescents with presence of risk factors for chronic diseases, such as hyperlipidemia and hypertension, these approaches are not without potential risks and side effects. Unfortunately, there is a lack of data on effective non-pharmacological approaches to manage chronic disease risk factors in this age group. This thesis will examine the efficacy of a dietary intervention targeted to adolescents with hypertension and pre-hypertension that is grounded in a theory for behavior change and is developmentally appropriate for this age group. It is anticipated that success of this intervention will provide a means by which adolescents with hypertension can be successfully managed in the clinical setting in the future.
REVIEW OF LITERATURE

Hypertension affects nearly 50 million Americans in this country with as many as 5% of the pediatric population suffering from this disorder (3). The problem and associated complications of the disorder in youth will be the focus of this literature review. This review will provide an overview of hypertension in youth, the prevalence of this health problem, the rationale for early intervention, and recommendations for treatment with an emphasis on dietary intervention. There is empirical evidence that behavioral interventions that are based on a unified theoretical framework are often successful at changing health-related behaviors. This literature review will also discuss current behavioral theories used in changing diet-related behaviors among adolescents and children. Additionally, gaps in the current literature with respect to dietary intervention approaches for managing hypertension in youth will be addressed.

I. Rationale for the Prevention and Treatment of Hypertension in Youth

With more than sixty percent of the U.S. population being overweight or obese, the number of cases of cardiovascular disease has increased as well. Millions of adults are affected by this disease every year, making public health efforts directed at prevention of the disease of high importance. The number of overweight children in the U.S. is following adult trends, contributing to the rise in early onset of CVD risk factors in this age group, including Type 2 Diabetes, hyperlipidemia and high blood pressure (4). Based on recent evidence gathered from health-screening programs in schools, increasing prevalence rates of hypertension and pre-hypertension among school-age children were related to increasing body mass indices (BMI) (5). In this report, hypertension was detectable in about 30% of the overweight children (BMI > 95th percentile). Other risk factors for cardiovascular disease appear to be associated with increased BMI in youth as well, including high LDL cholesterol, high triglycerides and low HDL cholesterol (6). Whether this atherogenic profile increases risk for developing CVD in early life is the subject of debate.
The Pathological Determinants of Atherosclerosis in Youth (PDAY) study, performed pathobiological studies of coronary arteries in over 3000 deceased youth aged 15-34 years old, who had died from causes unrelated to CVD. Findings from this study show that BMI was positively associated with the presence of raised atherosclerotic lesions in coronary arteries (7). This finding is important in light of substantial evidence that raised lesions on coronary vessels determine the risk of coronary heart disease and associated clinical complications (8).

The PDAY study also showed that in combination with other cardiovascular risk factors (e.g. high blood pressure, high LDL cholesterol, high triglycerides) the extent of the lesions in adolescents and young adults increased in coronary and abdominal arteries (7). Importantly, the negative effect of hypertension on raised lesion formation remained strong even in the presence of a favorable lipoprotein profile (8). However, those youth with more than one risk factor were more likely to have a greater percentage of the intimal surface area of their arteries covered with raised plaques; advanced lesions were 8.5 times more likely to occur and the extent of the fibrous-plaque lesions in the coronary arteries was twelve times as great in adolescents and young adults with three or more risk factors as compared to those with none (9). Similar findings have been reported by others (10).

Taken together, these findings suggest that cardiovascular risk factors, such as hypertension, hyperlipidemia and being overweight, can contribute to early atherosclerosis and substantially affect the extent and severity of coronary and aortic lesion development. Importantly, the presence of high blood pressure in youth negatively affects this process, even in children and adolescents with a favorable lipoprotein profile. Programs designed to reduce early atherogenic risk factors may delay the age at which atherosclerosis begins and potentially contributes to reduced mortality from this disease in adulthood (8).
II. Recommendations for the Treatment of Pediatric Hypertension

With effective non-pharmacological prevention and treatment for hypertension and associated risk factors in adults, health experts suggest that CVD risk factors may be prevented in early life as well. According to the Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents (5), therapeutic lifestyle changes including weight loss, dietary changes and exercise, may be effective at preventing and controlling elevated blood pressure in children and teenagers, although the evidence to support these recommendations are based primarily on adult data.

Based on data from Rocchini et. al. (11, 12), current recommendations for treating high blood pressure in youth support prevention of excess weight gain to inhibit further increases in blood pressure (5). These researchers and others showed that maintaining a healthy weight led to 1) a lowering in blood pressure in those with high blood pressure (12), 2) a decreased blood pressure sensitivity to salt (11), and 3) a decrease in CVD-related risk factors, such as insulin resistance and dyslipidemia (13). Blood pressure tracking and weight-reduction studies beginning in childhood through adolescence and into adulthood further support a benefit to maintaining a healthy weight (or losing weight if overweight) on lowering blood pressure in youth (5).

The Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents encourages dietary modification to lower blood pressure, especially in those children who have blood pressure levels in the prehypertensive range as well as those with hypertension (5). Based on adult dietary intervention studies, the report suggests that hypertensive youth may benefit from a dietary increase in fresh vegetables up to 2 cups, fresh fruits up to 2 cups, fiber up to 25-30 grams per day, nonfat dairy foods up to 3 cups and a reduction of sodium intake to less than 2300 mg/day. This dietary pattern is often referred to as the Dietary Approaches to Stop Hypertension (DASH) diet, based on the study in which it was originally tested in adults (14). This diet is high in potassium, magnesium, folic acid, fiber and
low in fat. Studies in adults have shown that alterations in the dietary intake of these individual nutrients may lower blood pressure in adults (15,16).

III. Dietary Interventions to Lower Blood Pressure in Children and Adolescents

There are several documented studies that support the claim that a reduction in sodium and an increase in certain nutrients, such as calcium, potassium, and magnesium will decrease blood pressure over time in children. Additionally, macronutrients and specific combinations of foods have been shown to positively affect blood pressure in children. Simons-Morton and Obarzanek (15) reviewed many studies that examined the effect of these nutrients on blood pressure in children.

In regards to sodium, three of four well controlled dietary intake studies on sodium, reviewed by these researchers, (15) found significant positive associations between dietary sodium and systolic blood pressure (SBP), diastolic blood pressure (DBP), or both in children (17, 18, 19). Of seven well controlled studies examining the relationship between urinary sodium (a marker for dietary sodium) and blood pressure, three found a significant positive association between sodium and SBP or both SBP and DBP (20-22). A study by Gelejinse et. al. (23) analyzed data on urinary sodium and blood pressure longitudinally and controlled for weight, sex, age, height and other electrolytes. They found no significant association between sodium excretion and annual blood pressure change over seven years from ages 6 to 13 (23). Thus, although controversial, the majority of the studies examining the relationship between sodium and blood pressure in children support an association between higher sodium intake and higher blood pressure in children and adolescents (15).

Intervention studies that examined potassium and blood pressure in children are few. Three involved providing children with supplemental doses of potassium at a level of about 1500 mg/day and examining the effect of this dose in combination with dietary sources of potassium on blood pressure in children. Of these trials, Sinaiko et. al. (24) and Miller et. al. (25) found that potassium supplements were not associated with changes in blood pressure over time.
However, Gelejinse et al. (23) found a significant inverse relationship between urinary potassium (a marker for dietary potassium) and blood pressure in adolescents. After controlling for BMI, these researchers found a lower annual slope of change in SBP in supplemented versus non-supplemented adolescents over seven years.

Diets high in magnesium have also been associated with lower blood pressure in children. Of five observational studies done to investigate the effect of magnesium and blood pressure, the majority found significant inverse relationships between dietary intake of magnesium and either DBP or SBP (17,26,27). No intervention studies have been done examining dietary magnesium and blood pressure in children (15).

Eight observational studies were identified that examined the relationship between calcium and blood pressure in children. Five of these studies (17-19,26,28) used self reported dietary intake, two of which (18,19) found a significant negative association between calcium and DBP or SBP, and the other three (17,26,28) found no significant association. Three studies (29-31) also measured urinary calcium, but found no significant association. One randomized controlled trial (32) that tested the effect of 600 mg calcium supplementation showed a small, significant decrease in SBP. Based on this evidence, it can be concluded that more research on calcium and blood pressure is needed to determine whether higher dietary intake may be beneficial to prevent and treat high blood pressure in children.

Nutrient combinations obtained through dietary sources have also been examined for associations with blood pressure in children. The Dietary Intervention Study in Children (16) examined children’s dietary intakes of calcium, magnesium, potassium, the macronutrients, dietary cholesterol and total dietary fiber in relation to systolic and diastolic blood pressure. In general, the researchers found that eating more calcium, magnesium, potassium, protein and fiber was associated with lower SBP, and eating more total fat was associated with higher SBP and DBP. The greatest effects of all the nutrients studied came from magnesium and calcium, however. When the researchers looked at all nutrients in combination, consuming more calcium
and fiber was associated with lower DBP, and eating more fat was associated with higher SBP and DBP (16).

A recent study examined diets of children, ages 3-6 years, from the Framingham Children's Study (33), which followed dietary and health patterns of 95 families for eight years. In comparing all children in the cohort, those who consistently ate more servings of dairy foods, fruits and vegetables had the lowest SBP and DBP levels over time, while those who ate the least amount of these foods had the highest blood pressure levels over time.

Although studies on dietary patterns and blood pressure are few, observational evidence suggests that combinations of nutrients, when obtained through the diet may be beneficial in lower blood pressure in children. More studies are needed in this area.

IV. Behaviorally-focused Nutrition Interventions for Reducing Cardiovascular Risk in Youth

One reason cited for the lack of effective non-pharmacological approaches to manage high blood pressure in children is the lack of compliance to existing lifestyle treatment programs among young participants (34). Couch and Daniels (34) suggest that because adherence to dietary interventions may be particularly problematic among children and adolescents, innovative nutrition intervention approaches are needed that address the unique needs and circumstances of this age group.

There is empirical evidence that nutrition education interventions that are based on a theoretical framework are effective in targeting programs to specific audiences and tend to be more successful at changing diet-related behaviors than those interventions that do not use such frameworks (35). While many behavioral theories have been used in designing dietary interventions for children including the “Theory of Planned Behavior” and the “Stages of Change Model,” the theory that has been most effective is the Social Learning Theory, also known as the Social Cognitive Theory (SCT).
This theory emphasizes cognitive interpersonal and environmental factors that influence the acquisition of healthy behaviors. The basic premise of the SCT is that a person’s behavior is influenced by continuous interaction between their personal characteristics and the environment. According to the theory, personal characteristics include knowledge related to the outcomes of their behavior (outcome expectancies), knowledge of skills related to performing a specific behavior (behavioral capabilities), and one’s degree of confidence in performing a particular behavior (self-efficacy). These elements of the SCT are often cited as the most valuable in designing effective health education programs (36-38). Changes in these constructs of the SCT are often measured in dietary intervention studies to determine whether behavior changes have been made as a result of the intervention (36). Additional constructs of the SCT include self-control, reinforcements, observational learning and social support. These theory elements are often used in the design of nutrition intervention programs. For example, self-monitoring and contracting are used to enhance self-control, rewards are used to reinforce appropriate behaviors, observation of credible role models is used to support observational learning and social support is enhanced through guidance and encouragement from family and program staff.

An example of a dietary intervention study conducted with children based on the SCT is the Dietary Interventions Study in Children (DISC) (39). The primary aim of the DISC study was to lower LDL-cholesterol levels in children with hypercholesterolemia by lowering their dietary intake of total fat, saturated fat, and cholesterol. In designing this behaviorally-based dietary intervention trial, the researchers used many of the constructs of the SCT. As examples, the theory states that behavior is learned through observation and imitation of models such as parents, siblings, family members, and peers. The DISC study incorporated a series of family oriented diet education and behavioral sessions led by nutritionists, behaviorists, and health educators. This allowed the children to have access to social support and opportunities that may not have otherwise been available. The intervention also helped children set goals and
keep track of food eaten (self-control), taught families low fat cooking and meal preparation skills (observational learning), and emphasized rewarding for meeting study-related goals (reinforcement).

Individual sessions with the child and parent or guardian followed the group sessions during which staff obtained periodic capillary blood cholesterol measures, provided feedback, and answered questions regarding the child’s progress toward the dietary goals, nutritional adequacy, and growth. It was during these sessions that most of the constructs of the SCT were measured. The usual care group was informed of their child’s high blood cholesterol, but was not given any recommendations to see a physician. They were given educational publications on healthy eating and test results were sent to their physician after three years.

Results of the DISC study showed a greater decrease in serum cholesterol, total energy intake and waist to hip ratio in the intervention group versus the usual care group. Also, the depression score that was taken during the psychological assessment was lower at three years in the intervention group than in the usual care group. Although this was unexpected, these findings suggested that the behavioral approaches used, which included the social support through group sessions and family members, may have had a positive impact on the child’s progress. In regards to dietary intake, the mean percentage of energy from total fat, saturated fat and mean cholesterol intake decreased in the intervention group at one and three years and was significantly greater than that achieved by the usual care group. There were no results given on the improvement of self-efficacy or self-control in either of the two groups.

The Child and Adolescent Trial for Cardiovascular Health (CATCH), a three year multi-site study of school-based interventions designed to reduce or prevent the development of risk factors for cardiovascular disease, also showed that a theory based intervention, the Social Cognitive Theory in particular, helped change psychosocial determinants of cardiovascular disease risk behavior among children.
The schools that participated were divided into three treatment conditions: a control (no treatment), a school-based intervention, and school-plus-family based intervention. The CATCH curricula were designed to influence self-efficacy and self-control related to diet-related skill acquisition. Self-regulatory processes, such as self-monitoring and goal-setting activities were added during the second and third years of the study. In order to measure self-efficacy, a scale was developed to encourage the children to choose foods lower in fat and sodium. The intervention also addressed individual cognitive processes and behavioral processes and influences, as well as the physical and social environment. The intervention included a series of skill-based classroom curricula, modifications of the school environment, and home based activities, which allowed the children to have more control over their choices for diet and physical activity behavior (40).

Results of the CATCH study showed that knowledge, the child’s selection of healthy foods, and dietary intention to change to a more healthful eating pattern improved significantly within the intervention schools across the three year time period. Dietary self-efficacy increased moderately during the third grade, but declined two years after the fifth grade. The researchers suggest that this decline in self-efficacy may have been due to barriers encountered by this age group (mass media messages, social persuasion, fast food, etc.)

Overall, results from the DISC and CATCH studies showed that use of a behaviorally based dietary intervention grounded in Social Cognitive Theory was an effective means of modifying dietary behavior in children at risk for CVD. Whether similar interventions would be equally successful with adolescents, particularly those with diagnosed CVD risk factors such as hyperlipidemia or hypertension, has not been determined.

VI. Gaps in the Literature

Based on the above discussion, it is clear that more dietary intervention trials are needed, particularly those that are theory-based, that tackle dietary change among hard to reach populations, such as children and adolescents. It would be expected that use of age-
appropriate behavioral theories for dietary intervention trials directed at these age groups would enhance the compliance with and the effectiveness of these interventions. Successful dietary interventions are sorely needed for children and adolescents with presence of risk factors for chronic diseases such as obesity, hyperlipidemia and hypertension. New treatment guidelines for children and adolescents with hypertension from The Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents (5), in combination with successful treatment approaches, could have a profound effect on improving the cardiovascular health of children and adolescents into adulthood. The DASH diet appears to hold particular promise as a dietary approach that may successfully control high blood pressure among populations at risk, regardless of age.

PURPOSE

To evaluate the effectiveness of a clinically-based, developmentally appropriate nutrition education intervention emphasizing fruits, vegetables, dairy products and low-fat, low-sodium foods (the DASH-4-Teens Diet) on changing dietary knowledge, diet-related self-efficacy and dietary intake in adolescents with pre-hypertension and hypertension.

HYPOTHESIS

It is anticipated that adolescents who participate in the DASH-4-Teens intervention will have a greater knowledge about diet as it relates to managing blood pressure, a greater self-efficacy with respect to performing skills necessary to modify diet, a greater intake of fruits, vegetables, and low fat dairy products, and a lower intake of high fat, high sodium foods (DASH unfriendly foods) immediately after the intervention and 3 months after treatment cessation than adolescents who receive usual care.
METHODS

Participants/Recruitment

Subjects of the study were recruited from all 11-18 year old children who were referred to the Cincinnati Children’s Hypertension Center (CCHC), which is a referral program for the diagnosis and treatment of children with hypertension. Children are usually referred to the Center by their primary health care provider after a systolic or diastolic blood pressure reading above the 95th percentile for the child’s age and height has been recorded. The diagnosis of hypertension is made after two additional readings of systolic or diastolic blood pressures above the 95th percentile have been recorded at the Center. All children also undergo a complete medical history and physical examination to help target the causes of the hypertension and other general screenings studies for cardiovascular risk factors, including weight and serum lipids. A family history of cardiovascular disease in the parents, grandparents and aunts and uncles is also obtained. Those children who had been diagnosed with hypertension and were enrolled in the CCHC were considered for participation in the study. Adolescents were excluded, however, if they had any secondary causes of hypertension, such as renal disease or diabetes, if they were taking medications to treat high blood pressure, and/or if they are unwilling to stop the use of vitamins, minerals or antacids containing magnesium or calcium.

A total of 57 adolescents were enrolled in the study, of which 46 were randomized, to receive either usual care (n=23) or the DASH-4-Teens (n=23) nutrition intervention. Adolescents that were not randomized either cancelled or did not attend the baseline visit. Seventy percent of the participants were boys, and 65% were white. All parents and adolescents signed consent forms before participating in the study. The study was approved by the Institutional Review Board at Cincinnati Children’s Hospital Medical Center.

Sample size for the study was based on a repeated measured design with three measurements per subject made at equally spaced intervals, a correlation between intra-subject measurement = 0.5, and an estimate of systolic blood pressure standard deviation = 8.3 mm
Hg. With this, a sample size of 45 subjects per group would allow a difference between group means = 2 mm Hg to be detected as statistically significant at the 5% level with 80% power. Recruitment for this study is ongoing. This thesis provides a preliminary evaluation of the first 23 subjects who participated in the DASH and usual care intervention.

**Study Design**

Participants were recruited at their initial visit to the Cincinnati Children’s Hypertension Center (CCHC) from waiting room flyers and by the Center cardiologist and registered dietitian. After agreeing to be in the study and signing informed consent forms, participants met with the dietician who trained them on how to use the 2-dimensional portion size model to estimate portion sizes of a variety of foods and beverages. The patient was informed that a dietician would call them on three random days over the course of the following two weeks to obtain 24 hour food recalls. The adolescents had their blood pressure taken twice on their right arm and in the seated position at the CCHC by trained personnel using a standard sphygmomanometer. Complete medical histories were taken, along with a physical examination, and biochemical data to rule out secondary causes of hypertension. Subjects completed a knowledge and self-efficacy questionnaire. (See tool description in “Methods” Section)

The family returned to the Center for a follow-up visit approximately two weeks after the initial consultation. At that time, the patients had their blood pressure taken and height and weight were recorded. Two in-clinic blood pressures, along with the blood pressure taken at referral, were used to make the diagnoses of hypertension or pre-hypertension. The Center cardiologist reviewed the patients’ blood pressure readings, medical, physical and biochemical data to rule out secondary causes of hypertension. Once deemed eligible for participation, subjects were randomized to treatment groups. Randomization occurred by selection among opaque envelopes containing a DASH or usual care card. Cards were stratified by gender and race. The randomized subjects then met with the dietician to be counseled on their specific treatment and scheduled for a follow up visit three months later. Those on the DASH-4-Teens
intervention received weekly telephone calls and mailings as part of the treatment, but no further follow-up was provided for the usual care group. However, both interventions received telephone calls before their three month visit to obtain dietary intake information.

Two weeks before the three month follow-up, participants received three telephone calls from a registered dietician on three random days to obtain dietary intake information. At each follow-up visit, a routine physical was performed, along with measurements of height, weight, and three blood pressure readings, knowledge and self-efficacy following the same procedures as described at baseline. No additional nutrition counseling was provided at this time. The next appointment was scheduled for three months later and the same procedures were repeated at the post-treatment visit. Subjects in the intervention and usual care group were both given $20.00 for travel to the follow-up visits.

**DASH Intervention**

The DASH-4-Teens intervention that was used in this study was slightly modified from the adult DASH diet (38) so the adolescents were able to meet their specific nutritional needs (Table 1). The diet met the terms of the current DRI's for males and females 11-18 years of age for energy, macronutrients, fiber and micronutrients.
Table 1. DASH-4-Teens Eating Pattern and Nutritional Analysis

<table>
<thead>
<tr>
<th>DASH 4 Teens Diet Plan</th>
<th>Age</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td></td>
<td>11-13</td>
<td>14-18</td>
<td>11-13</td>
<td>14-18</td>
</tr>
<tr>
<td><strong>Serving Recommendations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grains</td>
<td>7</td>
<td>9</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Vegetables</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Fruits</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Dairy</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Meat</td>
<td>6 (oz)</td>
<td>6 (oz)</td>
<td>6.5 (oz)</td>
<td>7 (oz.)</td>
</tr>
<tr>
<td>Nuts and Seeds</td>
<td>4 per week</td>
<td>4 per week</td>
<td>4 per week</td>
<td>4 per week</td>
</tr>
<tr>
<td>Fats &amp; Oils</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Sweets</td>
<td>5 per week</td>
<td>5 per week</td>
<td>5 per week</td>
<td>3 per day</td>
</tr>
<tr>
<td><strong>Nutritional Analysis (% DRI)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calories</td>
<td>2097 (101%)</td>
<td>2373 (100%)</td>
<td>2292 (101%)</td>
<td>3170 (101%)</td>
</tr>
<tr>
<td>Protein (% kcal)</td>
<td>18.4%</td>
<td>17.3%</td>
<td>18.5%</td>
<td>16.0%</td>
</tr>
<tr>
<td>Carbohydrate (% kcal)</td>
<td>51.2%</td>
<td>52.3%</td>
<td>52.3%</td>
<td>53.9%</td>
</tr>
<tr>
<td>Fat (% kcal)</td>
<td>30%</td>
<td>30%</td>
<td>29.2%</td>
<td>30%</td>
</tr>
<tr>
<td>Sodium (mg)</td>
<td>2203 (92%)</td>
<td>2235 (93%)</td>
<td>2277 (95%)</td>
<td>2199 (92%)</td>
</tr>
<tr>
<td>Potassium (mg)</td>
<td>3190 (160%)</td>
<td>3750 (188%)</td>
<td>3716 (186%)</td>
<td>4223 (211%)</td>
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<tr>
<td>Calcium (mg)</td>
<td>1481 (114%)</td>
<td>1357 (104%)</td>
<td>1329 (102%)</td>
<td>1435 (110%)</td>
</tr>
<tr>
<td>Magnesium (mg)</td>
<td>366 (153%)</td>
<td>445 (124%)</td>
<td>429 (179%)</td>
<td>594 (145 %)</td>
</tr>
<tr>
<td>Fiber (g)</td>
<td>25 (97%)</td>
<td>27 (106%)</td>
<td>31 (101%)</td>
<td>37 (99%)</td>
</tr>
</tbody>
</table>

The intervention components were designed to help the adolescents conform to the DASH-4-Teens eating plan and were based on The Social Cognitive Theory. The intervention was 12 weeks long and included one individualized counseling session, 10 telephone contacts and four mailings. The format was modeled after a nutrition intervention for overweight adolescents developed by Saelens et al. (41). This study found that adolescents experience a greater amount of weight loss when engaged in behaviorally oriented telephone calls and mailings, which was shown to be cost effective and an easy way to distribute information to adolescents (41).

The participants met with a dietician for a 45-60 minute counseling session, in which they were provided with a 10-module, illustrated manual on the DASH-4-teens diet plan. Sections 1-5 of the manual reviewed the DASH-4-teens diet components and provided activities...
to reinforce learning. Sections 6-10 focused on behavioral skills for changing dietary behavior. Sections 1-5 were reviewed in the counseling session with the dietitian. Additionally, the adolescent’s current eating habits were discussed and an action plan for meeting the DASH-4-Teens dietary goals (increasing fruits and vegetables, increasing low-fat dairy products, decreasing low-fat, low-sodium food choices) was developed. The action plan included short range goals, strategies to achieve these goals, and how to overcome obstacles. Sections 6-10 of the manual were mailed to the teens, one section per week, as the information from each section was discussed with the teen and a telephone interventionist.

Telephone contacts to the subject began one week after the initial counseling session. Telephone interventionists were trained by Dr. Brian Saelens (a developmental psychologist at Cincinnati Children’s Hospital Medical Center) in the provision of dietary behavioral modification strategies. Counselors used detailed call scripts and were audio taped to ensure compliance to these scripts. Subjects were contacted each week for eight weeks and biweekly for the last four weeks. The calls lasted 20 minutes and addressed food self-monitoring, dietary goal attainment, and specific behavior change strategies, which focused on those behaviors that are central to the Social Cognitive Theory (Table 2). Parents also received four one-page information sheets that contained behavior modification strategies for parents to use in helping their child follow the DASH-4-Teens eating plan.
Table 2. Theoretical concepts used to develop nutrition intervention and selected concept applications

<table>
<thead>
<tr>
<th>Concept and (Definition)</th>
<th>Selected Concept Application</th>
</tr>
</thead>
</table>
| Outcome Expectation (understanding results of making behavioral changes) | - Discussed relationship between nutrients and blood pressure  
- Discussed the relationship between blood pressure and health  
- Discussed the benefits of following the DASH diet to manage blood pressure  
- Explained that low fat/low salt foods keep the heart healthy |
| Behavioral Capabilities (gaining the knowledge and skills necessary for dietary change) | - Participants applied concepts during face-to-face and telephone counseling sessions (i.e. planning menus, modifying recipes, preparing meals and snacks, setting goals and action planning)  
- A manual with activities was provided to participants to reinforce concepts discussed in counseling/telephone sessions.  
- Key concepts were illustrated with diagrams or pictures in the manual |
| Observational Learning (role modeling)                       | - Guided practice was provided for evaluating food labels, planning menus, and preparing DASH foods  
- Parents were instructed on ways to model healthy selection and consumption of foods |
| Self-efficacy (perceived confidence in performing a specific behavior) | - Curriculum activities allowed families to apply each new concept (i.e. measuring portion sizes, label reading, menu planning, identifying foods by food group) |
| Self-control (personal regulation)                           | - Daily monitoring of food intake by teens  
- Weekly goal establishment by teens  
- Weekly non-food reward established by teen |
| Social Support (guidance and encouragement from family, program staff) | - Parents and teen encouraged to work together to establish goals and action plans  
- Parents taught skills to create an eating environment conducive to meeting DASH goals  
- Bi-weekly mailings to parents on feeding strategies to enable attainment of the DASH-4-teen goals |

Each adolescent worked with the telephone interventionist to establish weekly dietary goals and strategies for achieving these goals. These goals included 1) keeping detailed food records; 2) increasing the intake of fruits and vegetables to meet the DASH recommendations; 3) increasing the intake of low-fat dairy foods, and 4) lowering the intake of high-fat, high-sodium foods to two per day. Teens were to meet these needs by lowering the intake of DASH-unfriendly foods, which are defined as foods with more than three grams of fat and 480 mg of sodium per serving. Each subject mailed in their food diaries to the interventionists each week,
and was awarded $1.00 for each DASH food related goal met. There was a potential to earn $48.00 if all DASH goals were met for the entire 12 week period.

**Usual Care**

For those subjects in the usual care group, a 45-60 minute face-to-face counseling session was given by a CCHC dietician. Adolescents were provided with a National High Blood Pressure Education Program’s booklet *Eat Right to Help Lower Your High Blood Pressure*, which was written at the 5th grade reading level. The booklet encourages the incorporation of fruits and vegetables, reducing dietary sodium to 2400 mg per day and following the food guide pyramid. After the initial counseling session, adolescents were not contacted until scheduling for their 3 and 6 month follow up visits, which will be provided by the same dietician as the DASH intervention.

**Measures**

All measurements were taken at enrollment, immediately after the intervention and at a 3-month follow-up visit. Methods for evaluating blood pressure, height and weight were previously reported, and results pertaining to these measures will not be reported as part of this thesis. These findings can be found in *Changes in Diet Quality and Blood Pressure among Adolescents with Hypertension in Response to a Dietary Intervention Emphasizing Fruits, Vegetables and Low-fat Dairy Products*, a thesis written by Kasey Vagedes (42).

**Knowledge**: To measure knowledge, a 15 item test was designed to assess outcome expectancy or motivational knowledge (knowledge that facilitates motivation to act) and instrumental knowledge (knowledge that is needed to take action) (37). The motivational knowledge questions (8 items) addressed the relationship between foods, nutrients and the DASH dietary pattern and blood pressure. The Instrumental knowledge questions (7 items) addressed skills needed to adopt new dietary behaviors (e.g. reading labels, food shopping, determining serving sizes of DASH foods). The test was multiple choice in format with a possible total score range of 1-15; 0-8 for motivational knowledge and 0-7 for instrumental
knowledge. Five dieticians with experience in management of pediatric hypertension reviewed the instruments for content validity; and the instrument was found to have acceptable content validity.

**Self-Efficacy**: A 10 item questionnaire was developed to assess the subject’s level of self-efficacy in performing diet-related skills necessary to modify their diet. These skills included reading food labels, setting and reaching food related goals, and shopping for healthful foods at the grocery store. The form was created from a questionnaire that was validated for internal consistency and test-retest reliability by Betts et al (43) in determining self-efficacy associated with altering fruit and vegetable intake among adolescents. Self-efficacy was rated using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

**Dietary Intake**: Three random 24-hour recalls were collected by trained personnel masked to the treatment assignment over a 2-week period prior to clinic visits. Adolescents were trained in use of a 2-dimensional portion size model (Nutrition Consulting Enterprises) to determine quantity of food eaten. Food recalls were analyzed for nutrient content using the Minnesota Nutrition Data Systems software (nutrition database version 5.0/35, 2004, Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN). Additionally, the number of servings consumed from fruits, vegetables, low fat dairy foods and high fat sodium foods was calculated. Nutrition Data Systems summary file data containing each food item consumed were used to conduct food group analyses. Many foods consumed appeared in the summary file as ingredients; gram weights of ingredients were combined into a single whole-food weight that could be assigned to a food group according to the *Food Guide Pyramid* (8).

**Statistical Analysis**

Discrete and continuous variables were compared between groups using chi-square and t-test, respectively. To assess change in diet, anthropometric measures and blood pressure between evaluations, least square mean change between baseline and post-treatment (end of the intervention) and baseline and 3-month follow-up (end of study) were compared between
groups using analysis of covariance with baseline values of each variable as the covariate. All statistics were calculated using the Statistical Analysis Systems for Windows (version 8m, 2005, SAS Institute, Cary, NC).

RESULTS

Study Participants

After randomization, a total of 46 subjects took part in the trial, 23 in the DASH-4-Teens intervention and 23 in the Usual care intervention. Eighteen subjects in the DASH group completed the post-treatment assessment, while 15 subjects in the Usual care group completed the post-treatment assessment. Eleven subjects in the DASH group completed the 3-month follow-up assessment, and 10 subjects in the Usual care group completed the 3-month follow-up assessment. Results will be presented only for those subjects that completed either intervention. Groups were closely matched for age, gender and race: DASH versus Usual Care: age, mean ± S.D.: 14.2 ± 2.5 versus 14.3 ± 2.4 years; gender (males/females): 12/5 versus 9/6; and race (whites/blacks): 11/6 versus 10/5. It should be noted that an “intention to treat-analysis” was performed on the data, bringing baseline forward for those subjects who did not complete the intervention. The findings did not differ from those presented herein.

Knowledge and Self-efficacy Outcomes

At baseline, motivational knowledge of study participants in the DASH and Usual care groups was similar (Table 3). Motivational knowledge relates to facts that can facilitate or motivate a person to change their behavior, in this case alter their diet to include nutrients and foods that could potentially modify blood pressure. The high initial scores for this variable in both groups indicated that the adolescents in the study had a significant level of knowledge pertaining to food and blood pressure before the intervention. Notably, immediately after the intervention, the adolescents who participated in the DASH-4-Teens Intervention had a significantly greater increase in motivational knowledge compared to adolescents who participated in the Usual Care intervention. This significant knowledge gain was maintained
through their 3-month follow-up evaluation. Instrumental knowledge relates to knowledge about skills needed to change behavior; for example, how to identify high sodium foods from a list of food choices. Groups were similar with respect to instrumental knowledge scores before the intervention (Table 3). Instrumental knowledge gain was significantly greater in the DASH group compared to the Usual care group immediately after the intervention. There was a trend for this knowledge to be retained among DASH subjects versus participants in the Usual care intervention.

Self-efficacy relates to the adolescent’s confidence in their ability to perform diet-related skills that may lead to managing their blood pressure; for example how confident they were about eating eight servings of fruits and vegetables each day. On the self-efficacy tool used in this study, a lower score indicated a greater degree of self-efficacy with possible score ranges from 10-50. At baseline, both groups were closely matched for degree of diet-related self-efficacy (Table 3). The low initial scores in both groups indicated that the adolescents who participated in this study already had a high degree of confidence in their ability to perform diet-related skills that could manage their blood pressure. The change in self-efficacy score was not significantly different between the groups post-treatment, but at 3-months follow-up assessment, there was a trend for a greater gain in self-efficacy in the DASH group compared to the Usual Care group.
Table 3. Change in Knowledge and Self-Efficacy related to diet and blood pressure management after completing the DASH-4-Teens or Usual Care Intervention

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Baseline DASH (N=18)</th>
<th>Usual Care (N=15)</th>
<th>Post-treatment DASH (N=18)</th>
<th>Usual Care (N=15)</th>
<th>3-month Follow-up DASH (N=11)</th>
<th>Usual Care (N=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivational Knowledge Score a</td>
<td>6.0 (1.1)</td>
<td>5.7 (1.7)</td>
<td>7.4 (0.6) **</td>
<td>5.7 (1.5)</td>
<td>7.4 (0.9) *</td>
<td>5.9 (1.6)</td>
</tr>
<tr>
<td>Instrumental Knowledge Score b</td>
<td>4.2 (1.7)</td>
<td>3.7 (1.6)</td>
<td>6.4 (0.7) *</td>
<td>4.3 (1.8)</td>
<td>6.0 (1.3)</td>
<td>4.1 (1.2) †</td>
</tr>
<tr>
<td>Total Knowledge Score c</td>
<td>10.3 (2.3)</td>
<td>9.4 (2.7)</td>
<td>13.8 (1.1) **</td>
<td>10.0 (2.4)</td>
<td>13.4 (1.9) *</td>
<td>10.0 (2.3)</td>
</tr>
<tr>
<td>Self-Efficacy Score d</td>
<td>21.1 (4.9)</td>
<td>21.8 (5.2)</td>
<td>17.1 (5.6)</td>
<td>21.3 (4.4)</td>
<td>16.5 (3.2)</td>
<td>23.2 (5.6) †</td>
</tr>
</tbody>
</table>

a Motivational knowledge-relates to facts about diet and blood pressure that could facilitate motivation to act, possible score range is 0-8 with a high score indicating greater knowledge; b Instrumental knowledge Score- relates to knowledge that is needed to take action, possible score range 0-7 with a high score indicating greater knowledge; c Total Knowledge Score is the additive score of motivational and instrumental knowledge, possible score range is 0-15 with a higher score indicating greater knowledge; d Self-Efficacy Score – possible score range is 10-50 with a lower score indicating greater self-efficacy. Post treatment and follow-up differences were assessed by Repeated measures ANOVA adjusted for baseline differences in knowledge and self-efficacy. † = p<.10; * = p<.01; **= p<.001

Dietary Outcomes:

At baseline, the DASH group versus Usual care group were closely matched for intake of fruits and vegetables and low fat dairy foods (Figure 1). However, teens in the DASH group were consuming significantly more high fat, high sodium foods (HFS) before the start of the intervention than the Usual care group (p<0.01). Immediately after the intervention, the adolescents in the DASH group had a significant increase in fruits and vegetables (a gain of 1.6 servings per day, p<0.05), and a significant increase in low fat dairy foods (a gain of 0.7 servings per day) compared to the Usual care group. The DASH participants also had a significant reduction in high fat, high sodium foods compared to the teenagers in the Usual care group; a reduction of 1.6 servings per day among DASH participants versus a gain of 0.8 servings per day among teenagers in the Usual care group (p<0.05). At the 3-month follow-up visit, there were no significant differences between the DASH and Usual care group with respect to intake of number of servings of fruits and vegetables. There was a trend for a greater increase in intake of low fat dairy foods from baseline among DASH participants versus Usual
Care at this assessment ($p=0.07$). Additionally, there was a trend for a greater reduction in intake of high fat, high sodium foods at the 3-month follow-up visit among DASH versus Usual care participants ($p=0.07$).

**Figure 1** - FV = # of daily servings of fruits and vegetables; LFD = # of daily servings of low fat dairy foods; HFS = # of daily servings of high fat (>3 grams fat/serving), high sodium (>480 mg/serving) foods; Post treatment and follow-up differences were assessed by Repeated measures ANOVA adjusted for baseline differences in knowledge and self-efficacy. † = $p<.10$; * = $p<0.01$; ** = $p<0.001$
DISCUSSION

The DASH-4-Teens dietary intervention was designed based on Bandura’s Social Cognitive Theory (SCT) (37). This behavioral theory is considered the most widely used theoretical approach for promoting health behavior change among adolescents. The basic tenet of this theory is that behavior is influenced by continuous interaction between a person’s physical and social environment and their personal characteristics. Personal characteristics, as defined by Bandura (37), include a person’s outcome expectations, behavioral capabilities, and self-efficacy. Outcome expectations are the expected results of a behavior. The more positive the results are perceived to be the more likely the person will engage in the behavior. In the DASH-4-Teens intervention group, the adolescents received verbal and written information defining the outcome expectations associated with the program. These included 1) how consuming the DASH dietary pattern could favorably affect blood pressure, 2) how controlling blood pressure at a young age might prevent the developing of health problems later on, and 3) how consuming the DASH dietary pattern might improve other risk factors associated with cardiovascular disease (such as being overweight or obesity).

Setting clear outcome expectations at the beginning of the dietary intervention likely contributed to the more positive dietary changes observed among DASH participants versus the Usual Care group after the 12 week intervention, although this relationship was not assessed in this investigation. Providing detailed information to the DASH participants on the relationship between DASH foods and blood pressure, however, did enhance their motivational knowledge about the relationship between diet and expected health outcomes. Prior to the dietary intervention, motivational knowledge of the subjects in the DASH and usual care groups was similar, but high (6 and 5.7 respectively out of 8), which indicated that the adolescents already showed a significant level of knowledge pertaining to the relationship between food nutrients and blood pressure control. Immediately post-treatment and at the 3-month follow-up evaluation, however, those participants in the DASH-4-Teens group had a significantly greater
increase in motivational knowledge as compared to those in the usual care group, indicating that the DASH-4-teens curriculum was effective in delivering knowledge directed at motivating adolescents to modify their diet to lower blood pressure.

A gain in motivational knowledge does not always predict behavior change (36). According to the SCT, enhancing a person’s capability of changing a behavior comes from acquisition of sufficient knowledge and skills to perform the behavior correctly. Skill-based knowledge, or instrumental knowledge, was enhanced in the DASH-4-teens intervention by encouraging the adolescents to apply the concepts learned through curriculum-related activities. For example, the teens planned several menus with the DASH food serving recommendations, modified their current diets to include more servings of DASH foods, and modified recipes to be lower in fat and sodium. A DASH-4-Teens manual was provided to each DASH participant to reinforce the concepts discussed in the counseling session. Additionally, telephone contacts and mailings reinforced curricular concepts and assisted teens in setting food-related goals and strategies to achieve these goals. Acquisition of skills, in this study, was measured by a 7-item test and defined as “instrumental knowledge”, which is knowledge related to how to apply facts. Prior to the intervention, both the DASH group and usual care group showed similar instrumental knowledge scores, although instrumental knowledge was quite low pre-intervention (DASH versus usual care: 4.2 versus 3.7 out of 7). Immediately after the intervention, instrumental knowledge gain was greater in the DASH group compared to the usual care group. There was a trend for instrumental knowledge to be more strongly retained among DASH subjects versus the usual care group at the 3 month evaluation. These findings indicate that the DASH-4-teens curriculum was effective in delivering skill-based knowledge to the participants.

According to the SCT, enhancing a person’s self-efficacy toward changing a behavior is an important construct in modifying health behavior (36). Self-efficacy is defined as an individual’s perceived confidence in performing a specific behavior. According to Bandura (37,38), an individual with more self-efficacy or confidence in their ability to perform a specific
behavior is more likely to maintain this behavior to produce a desired outcome (36). Elements of the DASH-4-Teens curriculum that were designed to enhance the self-efficacy of the teen included 1) repeated opportunities through the counseling session and telephone contacts to apply new curricular concepts including portion size determination, label reading, and menu planning; 2) positive reinforcement from telephone interventionists when the adolescent met DASH food-related goals; and 3) repeated opportunities for the teen to set their own food-related goals and action plans.

Change in self-efficacy, in this study, was measured by a 10-item questionnaire designed to assess a participant's level of self-efficacy in selecting and following a dietary plan to lower blood pressure. Prior to the intervention, both the DASH and usual care groups showed a similar high degree of self-efficacy related to diet and blood pressure (as indicated by a low score on the questionnaire). Immediately post-treatment, the change in self-efficacy was not significantly different between the two groups. However, at the 3-month follow-up evaluation, there was a trend for a greater gain in self-efficacy in the DASH group as compared to the Usual care group.

The minimal change in self-efficacy achieved through the DASH-4-teens intervention may be related to a common problem observed in other dietary intervention trials with children and adolescents (39). The adolescents in this trial already came into the study with high degree of self-confidence in performing diet-related behaviors, like reading labels, setting food goals, and developing action plans. Therefore, there was little room for improvement. Also, the tool that was used to measure self-efficacy could have been a limitation. Based on this tool, self-efficacy was measured using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Perhaps a greater range in Likert scale values could pick up on more subtle changes between groups. Additionally, inadequate subject number in the clinical trial might have reduced our ability to discern group differences related to this variable.
Nonetheless, the trend toward a significant increase in self-efficacy at 3-months among the DASH group versus the usual care group is promising and suggests that the DASH-4-teens curriculum was effective in enhancing self-confidence related to implementing the DASH diet principles. Label reading allowed the adolescents to learn exactly what was in the food that they were eating, menu planning gave them the opportunity to see that it was possible to consume all the recommended nutrients in a day and measuring portion sizes allowed them to understand just how much they should actually eat. These activities, which the Usual care group was not exposed to, gave the DASH group extra practice in improving their self-efficacy and confidence in DASH diet-related skills and behaviors.

In addition to knowledge and self-efficacy, other SCT constructs included in the DASH-4-teens intervention were 1) observational learning – guided practice was provided to teens in evaluating food labels and planning menus 2) self-control – teens were expected to monitor and record food intake weekly, 3) social support – adolescents were encouraged to share and discuss information with their parents, and 4) reinforcement – program staff reviewed weekly food records and gave feedback. All of these components likely contributed to the efficacy of the DASH-4-teens intervention in changing dietary behaviors significantly more than those in the Usual care group, although changes in these constructs was not assessed. The greatest dietary changes achieved by DASH participants were those that were the targets of goal setting and action planning. Immediately after the dietary intervention, the adolescents in the DASH group reported consuming significantly more fruits, vegetables and low fat dairy products compared to the Usual care group. High fat, high sodium food intake was also reduced more among DASH participants versus the usual care teens. At the 3-month evaluation, there was no significant difference between the usual care and the DASH participants with respect to intake of fruits and vegetables, or low fat dairy foods. At this time point, there was a trend for the DASH group to maintain changes in their intake of high fat, high sodium foods compared to the usual care group. While the DASH-4-teens intervention appears effective in promoting positive dietary
changes related to blood pressure management, a longer term intervention may be needed to sustain diet-related changes among participants.

Throughout the intervention it was observed that the Usual care group did not improve as much as the DASH group, in regards to diet-related changes, knowledge and self-efficacy. This could have been due to type and amount of information the Usual care group received. Their diet instruction consisted of didactic information given in the form of a booklet which promoted eating foods low in sodium and fat and high in fruits and vegetables. Participants of the usual care group were also encouraged to make these dietary changes on their own and with the help of their family, but they did not receive the constant reinforcement of telephone calls and mailings. Furthermore, adolescence in the usual care group did not receive training on how to perform the skills necessary to implement the new diet within their environment - a central concept to the SCT.

In summary, based on the findings of this clinical trial, a curriculum based on the SCT focusing on the DASH diet proves to be efficacious in changing motivational and instrumental knowledge, self-efficacy and diet among adolescents with high blood pressure. Longer term follow-up with extended behavioral counseling may be needed to produce sustained behavioral effects in this age group.
REFERENCES


