UNIVERSITY OF CINCINNATI

Date: __July 2004________

I, __Barbara Lattin_________________________________________, hereby submit this work as part of the requirements for the degree of:

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in:

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It is entitled:

Efficacy of the DASH Diet to Manage Blood Pressure among Adolescents: Case Study Findings

This work and its defense approved by:

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Efficacy of the DASH Diet to Manage Blood Pressure among Adolescents: Case Study Findings

by
Barbara Lattin
July, 2004

Bachelor of Science, Dietetics
Masters of Science, Nutrition Science
Department of Nutritional Science
College of Allied Health Sciences

Sarah C. Couch, PhD, RD
Committee Chair
Abstract

Efficacy of the DASH Diet to Manage Blood Pressure among Adolescents: Case Study Findings

by
Barbara Lattin

Background: Hypertension is the most commonly diagnosed and treated health problem in the United States. It is a recognized risk factor for heart failure, kidney disease, and premature death. Current recommendations for the prevention and treatment of high blood pressure emphasize lifestyle modifications. The Dietary Approaches to Stop Hypertension (DASH) diet is currently considered one of the most effective non-pharmacological treatments for controlling blood pressure in adults. The Task Force on High Blood Pressure in Children and Adolescents suggests as many as five percent of the pediatric population has high blood pressure. The current treatment recommendation for children and adolescents diagnosed with elevated blood pressure is lifestyle change, including a low sodium diet, increased physical activity, weight loss, and the DASH diet. To date, the effectiveness of the DASH diet for children and adolescents has not been determined.

Methods: After an extensive literature review, it was determined an age-appropriate curriculum was needed. The DASH-4-Teens curriculum was developed based on the DASH principals (tailored to the dietary requirements of adolescents) and the Social Cognitive Theory, which has proven to be effective in guiding adolescents to change unhealthy dietary behaviors. The intervention includes a telephone and mail-based behavior modification component that can be easily added into the standard clinic-based treatment protocol.

Results: A clinical trial designed by the Department of Nutritional Science at the University of Cincinnati and Cincinnati Children’s Hospital Hypertension Center is ongoing. The four adolescents that have completed the DASH-4-Teens intervention have experienced blood pressure reductions (10mmHg/systolic, 2 mmHg/diastolic) consistent with reductions (11mmHg/systolic, 5mmHg/diastolic) in adults that participated in the DASH feeding trials and the reductions (14.2mmHg/systolic; 7.4mmHg/diastolic) found in free-living adults participating in the PREMIER Trial.

Conclusions: The results to date support the efficacy of the DASH-4-Teens curriculum developed for this study in managing blood pressure among adolescents.
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**Introduction**

Hypertension, blood pressure that rises and remains elevated, is the most commonly recognized risk factor for heart failure, kidney disease, and premature death.\(^1\) The National Heart, Lung and Blood Institute estimates one in four Americans suffer from hypertension\(^1\). As inactivity and obesity (common risk factors for Hypertension) continue to increase, the incidence and prevalence of the disease is also expected to increase.\(^1\)

Other than weight control and sodium restrictions, the primary treatment of hypertension prior to the 1990s was with medication.\(^2\) Based on a combination of findings of previous observational and intervention studies, the Dietary Approaches to Stop Hypertension (DASH) diet was developed.\(^3\) The diet emphasizes high levels of fruits, vegetables, and low fat dairy foods, while limiting fat and sodium.\(^4\) Adults that participated in the DASH feeding trial experienced a substantial reduction in blood pressure.\(^3\) Findings from the DASH feeding trial were replicated in the PREMIER clinical trial, a study involving 810 free-living adults.\(^5\) The DASH diet is currently considered one of the most effective non-pharmacological treatments for controlling blood pressure in adults.\(^6\)

The Task Force on High Blood Pressure in Children and Adolescents suggests as many as five percent of the pediatric population has high blood pressure.\(^7\) Children suffering from hypertension are at a greater risk for cardiac complications prior to their teen years.\(^8,9\) For these reasons, it is strongly recommended that hypertension be identified and treated in children and
adolescents to limit complications and promote improved cardiovascular health in adults.\textsuperscript{6}

The current treatment recommendations for children and adolescents diagnosed with elevated blood pressure (blood pressure greater than the 90\textsuperscript{th} percentile for age, gender, and height) include some pharmacological choices, but just as in adults, the primary recommendation is non-pharmacological, lifestyle-related behavioral changes.\textsuperscript{6} The behavioral changes, including diet modification to lower sodium, increased physical activity, weight loss, and the DASH diet, have either not been studied in children and adolescents, or the studies have been inconclusive.

While the DASH diet is currently being advocated for children and adolescents, it is unknown whether the diet is acceptable to this population or if the diet will produce the same blood pressure reduction found in adults. This study was designed to evaluate the acceptability, efficacy, and feasibility of the DASH diet for adolescents in a primary care setting.

\textbf{Literature Review}

Hypertension has been identified as a leading cause of heart disease, kidney disease, and premature mortality in the United States.\textsuperscript{1} The Task Force on High Blood Pressure in Children and Adolescents suggests that as many as five percent of the pediatric population have high blood pressure.\textsuperscript{7} This finding has resulted in new research focused on the cause, impact, and treatment of hypertension for children and adolescents. The following review of the literature
will define and classify hypertension, discuss the prevalence of this health problem and its potential to escalate, examine the health risks associated with high blood pressure, and explore the treatment recommendations and the rational for each recommendation.

Definition and Classification of Hypertension

Primary or essential hypertension refers to sustained, elevated blood pressure of unknown etiology. Secondary, non-essential, hypertension is defined as elevated blood pressure resulting from a defined cause, usually a renal or endocrine impairment.

Diagnostic criteria for adult patients with normal blood pressure, pre-hypertension, and overt hypertension have been established by the National Heart, Lung, and Blood Institute (NHLBI). NHLBI provides specific ranges for systolic and diastolic pressure within each blood pressure category along with treatment recommendations. Unlike adults, where the determination of hypertension is based on a single cut-off rate for systolic and diastolic pressure, a diagnosis of primary hypertension in children and adolescents is more complex. Elevated blood pressure in children and adolescents is defined as blood pressure that deviates from normal values. The reference values for systolic and diastolic pressure gradually increase in childhood due to the association between blood pressure, height and weight. Norms are assessed on a percentile curve based on age, gender, and height. Systolic and diastolic blood pressure in children and adolescents is considered normal if it is less than the 90th percentile, high normal if it is between the 90th to the 95th percentile, and
high (hypertensive) if it is above the 95th percentile. Blood pressure is considered severely elevated if either the systolic or diastolic pressure is greater than the 99th percentile.\textsuperscript{7} The normative tables for blood pressure established by the Task Force on High Blood Pressure in Children and Adolescents\textsuperscript{7} are based on data from more than 60,000 children from diverse ethnic backgrounds.\textsuperscript{11} By using percentiles to assess blood pressure in children and adolescents the severity of the blood pressure elevation can be determined quickly and treatment can be planned and implemented to avoid complications.\textsuperscript{11}

\textbf{Prevalence of Hypertension}

Hypertension is the most commonly diagnosed and treated health problem in the United States.\textsuperscript{1} The National Heart, Lung and Blood Institute estimates one in four Americans suffer from hypertension.\textsuperscript{1} In the United States the prevalence of high blood pressure escalates progressively with age, so that more than half of the population aged 60 years or greater have overt hypertension.\textsuperscript{5} The lifetime risk for developing hypertension in the United States is estimated to be 90\%.\textsuperscript{5} The majority of adults diagnosed with high blood pressure suffer from primary hypertension.\textsuperscript{10}

The Task Force on High Blood Pressure in Children and Adolescents suggests that as many as five percent of the pediatric population has high blood pressure.\textsuperscript{7} The majority of hypertension in infants and prepubescent children results from secondary causes, but approximately 10-15\% of all cases of high blood pressure in early childhood are classified as primary hypertension.\textsuperscript{11} The incidence of primary hypertension in later childhood and adolescence is on the
As obesity and inactivity (common risk factors for primary hypertension) in children and adolescents continue to increase, the incidence and prevalence of the disease is expected to increase. Even being mildly overweight may be related to an increase in blood pressure above normal in children and adolescents. A recent study depicting trends in pediatric blood pressure attributed the significant increase in systolic and the diastolic blood pressure of 1.4 and 3.3 mmHg, respectively, over the past decade among children and adolescents to an increased prevalence of overweight.

Of particular importance, elevated blood pressure in childhood and adolescence “tracks” into adulthood. Blood pressure readings, particularly systolic blood pressure taken during childhood, have been correlated to adult blood pressures. An above average blood pressure at age nine was associated with twice the likelihood of having an elevated blood pressure at age 21 in girls. Baseline systolic blood pressure (taken at the age of nine) was significantly correlated with systolic blood pressure at the age of 30 in males. These findings suggest that elevated blood pressure in childhood may put individuals at a greater risk for developing hypertension as adults.

**Health Risks Associated with Hypertension**

Primary hypertension is recognized as a risk factor for heart failure, kidney disease, and premature death. Blood pressure is an independent risk factor for cardiovascular disease events. The higher the blood pressure reading the greater the chance of heart attack, heart failure, stroke, and kidney disease. Data shows that for every increment of 20 mmHg in systolic blood pressure or 10
mmHg in diastolic blood pressure across the entire range of blood pressure classifications the risk of cardiovascular disease doubles for individuals 40-70 years of age.¹

Children suffering from hypertension are at a greater risk for cardiac complications at an earlier age.⁸,⁹ In childhood and adolescence, obesity-induced systolic hypertension has been linked to left ventricular hypertrophy.⁸ Elevated systolic blood pressure in childhood and adolescence is a risk factor for the development of arterial stiffness at a younger age.⁹ Due to these complications, as well as other cardiovascular risk factors, it is strongly recommended that hypertension be identified and treated early in childhood to limit complications and promote improved cardiovascular health in adulthood.⁷

Treatment Recommendations and Rational

Until recently, primary hypertension was considered an adult condition; thus treatments have been designed and developed for adults.⁷ Other than weight control and sodium restrictions, the primary treatment of hypertension prior to the 1990s was medication.⁵ Non-pharmacological therapies, in the form of lifestyle modifications, are currently favored by national health organizations for the prevention and treatment of hypertension.⁵ The lifestyle modifications recommended to lower blood pressure in adults are sodium reduction, weight loss, increased physical activity, the Dietary Approaches to Stop Hypertension (DASH) diet, and a reduction in alcohol consumption.⁵,¹⁵

As the incidence and prevalence of high blood pressure in children and adolescents increases the need for effective, long-term treatment without
complications is needed.\textsuperscript{2} The safety of blood pressure lowering medications has been limited to few clinical trials of short duration in the pediatric population.\textsuperscript{16} Just as with adults, the lifestyle modifications recommended by leading health organizations for children and adolescents are weight loss, increased physical activity, sodium reduction, and the DASH diet. However, these lifestyle modifications have either not been studied in children and adolescents, or the studies have been limited in duration or been inconclusive. In a review of several short-term studies, a blood pressure reduction was reported when weight loss occurred through reduced caloric intake and increased physical activity in children diagnosed as hypertensive.\textsuperscript{8} Although this suggests blood pressure reductions result from weight loss in obese children, none of the studies used a matched control group to show that the blood pressure reduction was directly related to the weight loss.\textsuperscript{8} Also, no documented studies have determined if the reduction in blood pressure associated with weight loss can be sustained over time.

Physical inactivity is an independent risk factor for hypertension in adults,\textsuperscript{17} but physical fitness does not relate as strongly to blood pressure in the adolescent population.\textsuperscript{18} Most studies that relate physical fitness and blood pressure are confounded by the subject’s weight or body mass index (BMI).\textsuperscript{17}

The effect of individual nutrients on blood pressure in children and adolescents has also been examined.\textsuperscript{19} The most widely studied micronutrient has been sodium. The etiology of hypertension shows that sodium chloride intake elevates vascular volume, increasing stroke volume and cardiac output,
ending with higher arterial pressure. Even though there is an overwhelming amount of evidence indicating a direct relationship between sodium and blood pressure in adults, the evidence has been less conclusive in children and adolescents. A review of fifteen observational and twelve intervention studies by D. Simons-Morton and E. Obarzanek concluded that there is no definitive relationship between sodium and blood pressure in children and adolescents. Importantly, these researchers sited poor study design and imprecise methodology used to assess sodium as a potential reason for a lack of relationship between sodium and blood pressure in this particular age group. In those observational studies in which precise measure for sodium intake were used, a significant, positive relationship between blood pressure and sodium intake was reported. However, three intervention trials sited in the review, in which children were studied with blood pressures in the upper percentiles, did not show a significant effect on lowering blood pressure when reducing dietary sodium. Although many studies completed to date on sodium and blood pressure are flawed with procedural problems, most health organizations agree that sodium intake among children and adolescents is well above recommended levels. Thus, there is a general consensus that children and adolescents should lower sodium to the current adult recommendation of two grams per day.

The study results for potassium and blood pressure have been inconclusive. Only half of the twelve observational studies reviewed reported a significant relationship between an increase in potassium and a reduction in blood pressure, and in one study the association between blood pressure and
potassium was in the opposite direction.\textsuperscript{19} Two clinical trials examining the potassium and blood pressure relationship reported no significant effect of the nutrient on blood pressure.\textsuperscript{19}

The majority of the observational studies reviewed did not find a significant relationship between dietary calcium and blood pressure.\textsuperscript{18,19} A few observational studies showed a significant inverse association, but the only intervention study showed no significance.\textsuperscript{18,19} Higher dietary magnesium may be related to lower blood pressure in children and adolescents based on a few observational studies.\textsuperscript{19}

Some macronutrients have been related to increased blood pressure in adults.\textsuperscript{15} The Multiple Risk Factor Intervention Trial (MRFIT) found that dietary cholesterol, saturated fat, and starch were positively related to blood pressure, while protein and the ratio of polyunsaturated to saturated fat were inversely related to blood pressure.\textsuperscript{15} The few studies examining the effects of macronutrients on blood pressure in children and adolescents have been inconclusive, but there is some evidence that macronutrients and fiber may affect blood pressure in this particular population.\textsuperscript{19} In the review, two observational studies found a significant inverse association between systolic blood pressure and both carbohydrates and polyunsaturated fatty acids, and between diastolic blood pressure and carbohydrates, cholesterol, fiber, and protein.\textsuperscript{19} The three intervention studies reviewed had poor design with varied results.\textsuperscript{19}

A major difficulty in studying nutrients independently is that they are found together and in conjunction with fiber in many food sources, thus confounding the
interpretation of results from observational studies.\textsuperscript{23} Also, the synergistic effect between the nutrients may be lost or distorted when studied independently as with intervention studies.\textsuperscript{3}

Based on a combination of findings from observational and intervention studies, the Dietary Approaches to Stop Hypertension (DASH) diet was developed and tested in adults.\textsuperscript{4} The DASH Trial was a multi-center feeding study that compared the effect of three eating patterns on lowering blood pressure.\textsuperscript{4} Unlike previous studies relating diet and blood pressure, the DASH trial tested whole dietary patterns associated with lower blood pressure.\textsuperscript{4} In adults with hypertension and pre-hypertension, this eating pattern lowered blood pressure as successfully as treatment with one medication.\textsuperscript{4} The diet expands the food guide pyramid by emphasizing a high number of servings of fruits and vegetables (9-12 servings), low fat dairy, whole grains, poultry, fish, and nuts while limiting fats, red meat, and sweets.\textsuperscript{4} By complying with the diet, dietary assessment measures have revealed total and saturated fat and cholesterol are reduced while levels of calcium, magnesium, potassium, dietary fiber, and protein\textsuperscript{4} are increased when compared to the typical diet in the United States.\textsuperscript{4} A sodium restriction (2 gram) in combination with the DASH diet was shown to produce a greater reduction in blood pressure then the diet alone.\textsuperscript{4} Notably, participants in the DASH feeding trial experienced a significant reduction in blood pressure, the reduction occurred quickly – within two weeks – and, blood pressure continued to remain low as long as the diet was followed. The exact mechanism for the diet’s success is unknown, but the most compelling theory,
based on previous studies, credits the combination of vitamins, minerals, macronutrients, and fiber found in whole foods. The DASH diet is currently considered one of the most effective non-pharmacological treatments for controlling blood pressure.6 The dietary recommendations determined by the DASH Collaborative Research Group24 meet or exceed the Dietary Reference Intakes for all 11-18 year old children and adolescents.25,26

To assess whether the DASH feeding trial successes could be replicated in a free-living population, the PREMIER Clinical Trial randomized 810 free-living adults with pre-hypertension to one of three treatment groups: 1) lifestyle modifications that comply with the National High Blood Pressure Education Program (NHBPEP) recommendations, weight loss, sodium reduction, increased physical activity, and limited alcohol intake; 2) the DASH diet combined with the NHBPEP recommendations, or 3) advice only group, a single 30-minute counseling session with a registered dietitian.5 Compliance to the dietary changes varied between intervention groups and food groups. Both the NHBPEP recommendations group and the DASH diet combined with the NHBPEP recommendations group significantly reduced weight, improved fitness, and lowered sodium intake.5 The DASH diet combined with the NHBPEP recommendations also increased fruit, vegetable, and dairy consumption.5 Only 34% of the participants in this intervention group met the daily goal of nine or more servings of fruits and vegetables, while just slightly more than 6% of the participants in the advice only and NHBPEP-recommendations groups met the dietary goal for fruits and vegetables. The daily goal of two or more dairy
servings was achieved by 59% of the participants in the DASH combined with the NHBPEP recommendations group, while 78% reduced dietary fat to 30% or less. Compliance to dietary goals for the advice only and NHBPEP recommendation groups were far below the DASH combined with NHBPEP recommendation group. After the six month intervention, the blood pressure reductions were greatest in the DASH diet combined with the NHBPEP group, and the results were consistent with the findings from the DASH Feeding Trial.

The Department of Family Medicine, East Carolina University successfully matched the results published by the DASH Group among a small group of patients in a primary care setting. The implementation and success of the DASH diet in a variety of settings enhances its value as a significant method of treatment for hypertension in adults. Even though the DASH diet is advocated by many health experts as a promising treatment of hypertension for all age groups, the efficacy of the DASH diet in treating hypertension in children and adolescents has not been ascertained.

**Social Cognitive Theory**

Adolescence is a time of tremendous change. Along with rapid physical growth, advances in emotional, intellectual, and social development are occurring quickly. Cognitively, thought patterns advance from limited reasoning based on concrete objects and specific experiences to more abstract reasoning. The adolescent is capable of understanding more abstract concepts, such as the association between food and health. Adolescents strive for a sense of self, while exerting independence from parents, family, and other adults.
and acceptance from peers is sought at the same time resentment of authority is displayed. These vast changes can leave this population nutritionally vulnerable. Many adolescents make the majority of their food choices. Unfortunately peer pressure, hectic schedules, a need to exert their independence, and lack of self-discipline can lead to unhealthy eating practices. Dietary patterns for this age group reflect food consumption that is high in fat and sugar, and low in fruits, vegetables, fiber content, and dairy foods. Importantly, dietary interventions designed to modify unhealthy adolescent eating patterns should consider the numerous environmental, social, and cognitive factors that impact the eating behaviors and food choices of this age group.

Theory-based interventions that target specific behaviors are more likely to result in behavior changes than interventions that provide only the knowledge necessary to make changes. The Social Cognitive Theory established by Bandura holds that there is a reciprocal relationship between the individual (including cognition), the environment, and behavior.

Key components of the SCT relevant to modifying dietary behaviors include outcome expectations, behavioral capabilities, observational learning, self-efficacy, self-control, social support, and reinforcement. Outcome expectations are the perceived consequences, both positive and negative, of a behavior. Behavioral capabilities refer to the knowledge and skills necessary to achieve the desired outcome, while observational learning is learning through role modeling. According to SCT, both elements are necessary components
of nutrition education to increase self-efficacy, which is defined as a person’s confidence in their ability to successfully perform a behavior. Self-control can be achieved through personal regulation and monitoring. Reinforcements are motivators to modify a person’s behavior. They can increase or decrease the likelihood of the occurrence of the behavior.

Intervention studies designed to change dietary behaviors in children and adolescents should include key elements of the SCT. To use the SCT the desired behavioral outcome must be specified and the variables most likely to influence the behavior must be identified. The theory is commonly used in research studies of health behavior changes in adolescents. The SCT has been used to modify physical exercise levels in adolescents, predict fruit and vegetable intake in children, and modify adolescent eating behavior.

The design of nutrition education programs for adolescents must accommodate the emotional, social, and cognitive characteristics associated with this target population. Additionally, with respect to programs to modify dietary patterns that influence health outcomes, such as blood pressure, dietary interventions must also be designed for use in the health care setting. Research has shown that adolescents respond favorably to one-on-one counseling over an extended period of time. Techniques derived from motivational interviewing provide a foundation that may validate the adolescent’s ideas and input. A nutrition counselor can offer acceptance, provide insight to problems, clarify solutions, and offer positive reinforcement. Self-efficacy can be strengthened while self-responsibility is emphasized. It’s important that parents play a
supportive role in the counseling process, as opposed to being intrusive.\textsuperscript{30,31} Dietary interventions have traditionally been designed as frequent face-to-face sessions between the counselor and patient. This process may produce positive results, but the design is expensive, can be unappealing to many due to the high level of commitment on the part of the patient, and can be difficult to implement in a primary care setting.\textsuperscript{38} A unique telephone-based behavioral modification program designed as an adjunct to a weight control program for adolescents was recently reported to produce favorable weight loss among adolescents when conducted in a primary care setting.\textsuperscript{39} The cost-effective program found that increased interactions through telephone and mail contacts were effective in facilitating weight-related behavior changes.\textsuperscript{39}

In summary, dietary interventions designed to modify health outcomes for an adolescent audience should be based on effective behavioral theory, developmentally appropriate for the target population, and easy to implement within the health care setting.

\textbf{Methods}

\textbf{Approach to Intervention Design}

Due to the unique cognitive and developmental needs of the target audience for the DASH-4-Teens intervention, it was determined that modification of the DASH Eating Plan and Manual (outlined in Table 1), which were originally developed for adults, would be required to maximize compliance. After an extensive literature review, it was determined the DASH-4-Teens program would
integrate the DASH dietary principals with key concepts of the Social Cognitive Therapy (SCT), which has proven to be effective in guiding adolescents to change dietary behaviors.

Table 1. Dietary Approaches to Stop Hypertension (DASH) Eating Plan

The DASH eating plan shown below is based on 2,000 calories a day. The number of daily servings in a food group may vary from those listed, depending on your caloric needs. Use this chart to help you plan your menus or take it with you when you go to the store.

<table>
<thead>
<tr>
<th>Food Group</th>
<th>Daily Servings (except as noted)</th>
<th>Serving Sizes</th>
<th>Examples and Notes</th>
<th>Significance of Each Food Group to the DASH Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grains and grain products</td>
<td>7–8</td>
<td>1 slice bread, 1 oz dry cereal, 1/2 cup cooked rice, pasta, or cereal</td>
<td>Whole wheat bread, muffin, pita bread, bagel, cereals, grits, oatmeal, crackers, unsalted pretzels and popcorn</td>
<td>Major sources of energy and fiber</td>
</tr>
<tr>
<td>Vegetables</td>
<td>4–5</td>
<td>1 cup raw leafy vegetable, 1/2 cup cooked vegetable, 6 oz vegetable juice</td>
<td>Tomatoes, potatoes, carrots, green peas, squash, broccoli, turnips, greens, collards, kale, spinach, arthichokes, green beans, lima beans, sweet potatoes</td>
<td>Rich sources of potassium, magnesium, and fiber</td>
</tr>
<tr>
<td>Fruits</td>
<td>4–5</td>
<td>6 oz fruit juice, 1 medium fruit orange, 1/4 cup dried fruit, 1/2 cup fresh, frozen, or canned fruit</td>
<td>Apricots, bananas, dates, grapes, orange juice, grapefruit, grapefruit juice, mangos, melons, peaches, pineapple, prunes, raisins, strawberries, tangerines</td>
<td>Important sources of potassium, magnesium, and fiber</td>
</tr>
<tr>
<td>Low fat or fat free dairy foods</td>
<td>2–3</td>
<td>8 oz milk, 1 cup yogurt, 1/2 oz cheese</td>
<td>Fat free (skim) or low fat (1%) milk, fat free or low fat butter milk, fat free or low fat regular or frozen yogurt, low fat and fat free cheese</td>
<td>Major sources of calcium and protein</td>
</tr>
<tr>
<td>Meats, poultry, and fish</td>
<td>2 or less</td>
<td>3 oz cooked meats, poultry, or fish</td>
<td>Select only lean; trim away visible fats; broil, roast, or boil, instead of frying; remove skin from poultry</td>
<td>Rich sources of protein and magnesium</td>
</tr>
<tr>
<td>Nuts, seeds, and dry beans</td>
<td>4–6 per week</td>
<td>1/2 cup or 1 oz nuts, 2 Tbsp or 1/2 oz seeds, 1/2 cup cooked dry beans</td>
<td>Almonds, filberts, mixed nuts, peanuts, walnuts, sunflower seeds, kidney beans, lentils, peas</td>
<td>Rich sources of energy, magnesium, potassium, protein, and fiber</td>
</tr>
<tr>
<td>Fats and oils†</td>
<td>2–3</td>
<td>1 tsp soft margarine, 1 Tbsp light salad dressing, 1 tsp vegetable oil</td>
<td>Soft margarine, low fat, light salad dressing, vegetable oil (such as olive, corn, canola, or safflower)</td>
<td>DASH has 27 percent of calories as fat, including fat in or added to foods</td>
</tr>
<tr>
<td>Sweets</td>
<td>5 per week</td>
<td>1 Tbsp sugar, 1 Tbsp jelly or jam, 1/2 oz jelly beans, 8 oz lemonade</td>
<td>Maple syrup, sugar, jelly, jam, fruit-flavored gelatin, jelly beans, hard candy, fruit punch, soft ice, ice cream</td>
<td>Sweets should be low in fat</td>
</tr>
</tbody>
</table>

* Equals 1/2 – 1 1/4 cups, depending on cereal type. Check the product’s Nutrition Facts Label.
† Fat content changes serving counts for fats and oils: For example, 1 Tbsp of regular salad dressing equals 1 serving; 1 Tbsp of a low fat dressing equals 1/2 serving; 1 Tbsp of a fat free dressing equals 0 servings.

Source: National Heart, Lung and Blood Institute.

The DASH Eating Plan was also modified slightly from the original version so that it more closely conformed to the unique nutritional needs of the adolescents for energy, macronutrients, fiber, and micronutrients. Daily food group servings required to meet the recommendations and conform to DASH dietary goals for male and female adolescents, aged 11 – 18 are shown in Table 2.
Table 2. DASH-4-Teens Eating Plan

<table>
<thead>
<tr>
<th>Gender</th>
<th>Female</th>
<th>Female</th>
<th>Male</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>11-13</td>
<td>14-18</td>
<td>11-13</td>
<td>14-18</td>
</tr>
<tr>
<td>Calories per day</td>
<td>2,000</td>
<td>2,400</td>
<td>2,200</td>
<td>3,000</td>
</tr>
<tr>
<td>Servings per Food Group per day</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(except where noted)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bread, Cereal, Rice &amp; Pasta (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>Milk, Yogurt, and Cheese (Dairy)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Meat, Poultry, Fish – 3 ounces per serving (Protein)</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Dry Beans, Nuts, Seeds, and Eggs (Protein)</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>5</td>
<td>5</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Sweets &amp; Desserts</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

A review of nutrition behavior research used with adolescents provided examples of the most commonly used models and theories for changing dietary behavior. A model explains how an intervention works, but does not attempt to determine why it works. A theory explains how and why principles are related in dietary behavior and provides the outline for use in the design of a nutrition intervention. The Health Belief Model and the Stages of Change Model are often used in health education research. Two theories commonly used to develop nutrition interventions are the Theory for Reasoned Action and the Social Cognitive Theory (SCT). The following is a brief discussion of the mentioned models and theories; and the process used to determine which one would be best for the DASH-4-Teens intervention.

The Stages of Change Model defines nine processes (stages) of change. Processes are defined as any activity initiated to help modify thinking, feeling, or behavior. Each process of change includes a number of techniques that could be used to help change behavior. For example, setting a time frame for change and developing a plan of action can be an effective technique for
achieving the process of commitment, defined as accepting responsibility for changing. This model was developed to modify a specific behavior, not several behaviors as proposed in the DASH-4-Teens intervention. The efficacy and feasibility of its use in nutrition intervention requires further examination. The Health Belief Model is a threat-avoidance model for preventing disease. Its applicability could be questioned if the target audience does not feel their health condition is life-threatening.  

The Theory of Reasoned Action contends that the strength of an individual’s attitude toward a behavior and the social environment influence the strength of an individual’s intentions to perform a specific behavior. The SCT explains behavior in terms of a reciprocal process in which personal factors, the environment, and behavior continuously interact. A basic premise of the theory is that people not only learn through their own experiences, but also through observing the actions of others and the results of the actions. The SCT can easily be applied to nutrition interventions. It has been used extensively in health education research, and is commonly used when health behavior change in adolescents is studied.  

Based on the multiple dietary changes required as a key outcome of the proposed DASH-4-Teen intervention as well as the unique cognitive and developmental needs of the target audience, the SCT was used to develop the DASH-4-Teens intervention. SCT provides a framework that addresses the concerns of the target population. Adolescents struggle to establish their own identity and independence from parents and other adults. A nutrition
intervention based on the SCT promotes self-efficacy through goal setting and problem solving, increasing the adolescent’s feeling of self-control. Altering attitudes, imparting knowledge and facilitating behavior changes in adolescents is more effective when the intervention is done on an individual basis, as opposed to a group setting, over a lengthy period of time. The theoretical concepts selected from the SCT for use in this intervention are outlined in Table 3.

Table 3. Theoretical concepts and applications used to develop the DASH-4-Teens curriculum.

<table>
<thead>
<tr>
<th>Theory Concept and Definition</th>
<th>Selected Concept Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcome expectations: expected behavioral results</td>
<td>- Confer the relationship between blood pressure (BP) control and health - Confer the relationship between nutrients and BP control - Confer the benefits of following the DASH eating plan to achieve optimal BP</td>
</tr>
<tr>
<td>Behavioral capability: knowledge and skills to achieve and maintain BP control</td>
<td>- Each participant receives manual to reinforce concepts introduced during counseling session and telephone contacts - Manual clarifies key concepts with diagrams and pictures - Concepts applied during curriculum activities by each participant (menu planning with DASH serving recommendations)</td>
</tr>
<tr>
<td>Observational Learning: role modeling</td>
<td>- Practice will be provided for evaluating food label nutrition information and menu planning based on the DASH-4-Teens eating plan</td>
</tr>
<tr>
<td>Self-efficacy: perceived confidence in performing a specific behavior</td>
<td>- Curriculum activities allow participants to apply concepts of eating plan</td>
</tr>
<tr>
<td>Self-control: personal regulation</td>
<td>- Daily monitoring and recording of food intake - Weekly goals established by participant - Weekly reward established by participant when goals met</td>
</tr>
<tr>
<td>Social support: guidance and encouragement from family and staff</td>
<td>- Encourage participants to share information with family members - Weekly opportunities for participants to interact with DASH staff through telephone contacts</td>
</tr>
<tr>
<td>Reinforcements: responses to specific behavior that increases/decreases repeated performance of behavior</td>
<td>- DASH staff review self-monitoring records weekly and provide oral and written feedback through telephone contact and mailings - Oral feedback from DASH staff on curriculum activities during individual counseling</td>
</tr>
</tbody>
</table>

Curriculum

The DASH-4-Teens curriculum (pictured in figure 1) was designed to provide each participant with the knowledge and skills needed to successfully accomplish the dietary goals of the intervention. An illustrated manual comprised of ten sections was developed. The first five sections (presented in a newsletter format) included an explanation of the relationship between hypertension and
diet, DASH dietary goals based on age and gender, and instructions, with reinforcing activities, on how to follow the DASH-4-Teens eating plan. The last five sections concentrate on the behavioral skills needed to change dietary behavior in order to achieve the goals of the intervention. The curriculum was presented to each participant through an initial face-to-face counseling session with a registered dietitian, weekly and biweekly telephone calls, and mailings.

Weekly dietary goals targeted keeping track of foods eaten, increasing intake of fruits, vegetables, and low fat dairy, and decreasing intake of DASH-unfriendly foods, defined as foods that contain more than three grams of fat and/or more than 480 mg of sodium per serving. DASH-friendly foods were defined as foods that contain less than three grams of fat and/or less than 480 mg of sodium. The newsletter also included a section for each of the targeted food groups. Each section was written and illustrated in an age-appropriate format. The food, recipe, and menu suggestions for each section were selected to appeal to adolescents. Each participant was encouraged to gradually increase weekly goals based on their current consumption of DASH foods and their ultimate DASH-4-Teens dietary goals. Self-monitoring booklets were provided for teens to record all food and beverages consumed on a weekly basis. Food monitoring had to be done five out of seven days each week to meet the program goal. A complete food record was defined as one containing a record of the time the food was eaten, where it was eaten, a complete description of the food or beverage, the amount consumed, and identification of whether the food or beverage was a fruit, vegetable, low fat dairy, or a DASH-unfriendly food.
Progress toward attaining weekly goals was determined by review of each adolescent’s food records by study personnel. Monetary rewards were provided for attaining weekly short-term goals. The newsletter also provided instructions on how to modify favorite foods, such as pizza and brownies, to meet DASH-friendly guidelines. DASH-friendly and unfriendly food lists were also included for quick reference.

The five behavioral skills outlined in the manual were food monitoring, goal setting, social support, dealing with barriers to change, and long term goal planning. All but the food monitoring sections were mailed to the participant prior to their weekly telephone call. Food monitoring information not only included complete instructions for performing the task, but also explained how food monitoring could help them change their diet and track their progress. Goal setting was stressed in a step-by-step progression with adolescents devising action plans for achieving goals and developing a reward system to maintain motivation. Social support stressed that reaching goals can be easier with help and encouragement. Barriers to change were defined as “risky situations” that could be overcome by choosing DASH friendly foods, changing unhealthy foods to DASH friendly foods, planning ahead by bringing along DASH friendly foods, or deciding on a little if they just had to have a DASH unfriendly food. Scenarios for commonly encountered barriers were provided for role-playing. Maintaining the dietary changes achieved during the intervention were addressed in the last section, long term planning. The behavioral skills were designed to empower participants to reach the goals of the DASH-4-Teens plan.
Since parents can influence an adolescent’s food choices\textsuperscript{31}, information sheets were developed for parents. The sheets contained behavior modification strategies parents could use to help their adolescents follow their DASH-4-Teens eating plan. The topics covered were positive encouragement, preplanning, role modeling, and saving money when shopping for DASH foods. All materials developed for the DASH-4-Teens curriculum were written at a fifth grade reading level.

\textbf{Figue 1: DASH-4-Teens Curriculum}

\begin{center}
\includegraphics[width=\textwidth]{DASH-4-Teens_Curriculum.png}
\end{center}

\textbf{Subjects}

Subjects were recruited from all newly enrolled patients aged 11-18 years referred to the Cincinnati Children’s Hypertension Center (CCHC). The diagnosis of hypertension is made after two additional readings of systolic or diastolic blood pressures greater than or equal to the 90\textsuperscript{th} percentile for age and height are recorded at the Center. All children undergo a medical history and physical examination aimed at detecting manifestations of hypertension, causes of secondary hypertension, and other general screening studies for cardiovascular risk factors. An extensive family history of cardiovascular disease
in parents, grandparents, aunts, and uncles is obtained. On average five new patients are enrolled at the Center each week, contributing approximately 225 new patients each year. The average age of the Center’s population is 13 years, with a range in age from 8 to 18 years. The racial make-up is approximately 80% white, and 20% African American children and adolescents. Approximately 75% of the patients are male. Nutritional intervention is the major therapeutic regimen for the majority of children at the Center.

Children diagnosed with primary hypertension (three consistent systolic or diastolic blood pressure readings made at least two weeks apart that are above the 90th percentile for age and height) who are enrolled at CCHC were considered for participation in the study. Exclusion occurred for the following reasons, 1) if they were found to have secondary causes of hypertension, such as diabetes or renal disease, 2) if they were taking medications that may alter blood pressure, 3) if they were enrolled at the Center greater than one year, 4) could not keep a food record describing the foods and beverages consumed for five of seven days prior to randomization, or 5) if they were participating in another research study. The age range for the study was 11-18 years. The DASH-4-Teens curriculum was developed at the 5th grade reading level and is developmentally appropriate for adolescents above the age of 11; for this reason children younger than 11 were excluded from the study. Informed consent was obtained from parents and children prior to participation in the study.

The first four subjects randomized to the DASH-4-Teens intervention group are described in the following case studies (see Results). They are part of
an ongoing clinical trial designed by the Department of Nutrition Science at the University of Cincinnati and Cincinnati Children’s Hospital Hypertension Center.

**Intervention**

The DASH-4-Teens nutrition intervention was twelve weeks in length. The information was disseminated through an individualized counseling session, ten telephone contacts, and four mailings. Once enrollment and eligibility were determined, participants randomized to the DASH intervention were presented with the DASH-4-Teens manual during a 60- to 90-minute face-to-face counseling session with the clinic’s dietitian. In the counseling session the dietitian reviewed the newsletter portion of the manual. The adolescents had an opportunity to complete several pen and paper with the dietitian to reinforce program concepts. At the end of the counseling session, the participant was instructed on how to complete and mail the self-monitoring food records. A schedule was determined for the upcoming telephone contacts and mailings.

The telephone calls began one week after the in-clinic counseling session was completed. Adolescents were contacted by the same telephone interventionist for all ten phone calls. Detailed call scripts were developed specifically for this intervention. The interventionists were trained by Dr. Brian Saelens, a child health psychologist at Children’s Hospital Medical Center in Cincinnati, Ohio, on the provision of dietary behavioral modification strategies to adolescents by telephone. Each participant received weekly calls for the first eight weeks and biweekly calls for the last four weeks of the intervention. The calls lasted 15 to 20 minutes and each call provided feedback and instruction on
self-monitoring, goal setting and attainment, and specific behavior change strategies outlined in the curriculum. As an incentive to achieve weekly goals, participants could earn points each week that could be converted to dollars at the completion of the intervention. Adolescents had to attain three of four goals each week to earn a weekly maximum of four points or four dollars. The four short-term goals set each week included 1) keeping a complete food record for 5 of 7 days, 2) eating a specific number of fruits and vegetables, 3) eating a specific number of low fat dairy, and 4) eating as few unfriendly food servings as possible. The long-term goal of the study was to gradually work each participant toward their ultimate DASH-4-Teens dietary goals by week eight of the telephone intervention. There were a total of 48 short-term goals, thus adolescents could earn a total of $48.00. Goal attainment was confirmed when each participant’s weekly food record was reviewed by study personnel. Interventionists rated each participant’s level of engagement during the telephone contacts using a Likert scale, with one being not engaged at all to five being very engaged. Action plans developed by the adolescents outlining strategies for goal attainment, written feedback for self-monitoring, the behavioral skills sections of the manual, and parent information sheets were mailed at appropriate times throughout the telephone intervention. It was suggested that participants share the details of the intervention with their parents; and parents were encouraged to participate in the nutrition intervention; however, because adolescence is a time for establishing independence, each participant determined the extent of parental involvement they deemed useful.
Blood pressure and anthropometrics were measured at baseline, at the completion of the intervention, and three months past the intervention by the nursing staff at CCHC. Participants had height and weight measured, without shoes, at each visit to the Center. Height was measured using a stadiometer. Weight was measured using a calibrated triple-beam balance scale. Participants had their blood pressure measured twice on the right arm and in a seated position by trained personnel using a standard clinical sphygmomanometer according to the procedures specified in the Update on the Task Force Report (1987) on High Blood Pressure in Children and Adolescents. Dietary change was determined by three random 24-hour dietary recalls at baseline and at the completion of the intervention by an independent contractor. When recruited, adolescents were provided a 2-dimensional portion size model, pictures of snack food items, and a chart that compared everyday items to portion size amounts. Adolescents were instructed to use the model, pictures, and chart to determine amounts of food consumed. The three random recalls at baseline were done during a two week period prior to their face-to-face counseling session with the Center’s dietitian. The recalls included dietary intake for two days during the week and one weekend day. The recalls at the completion of the intervention were done two weeks prior to their 3-month visit, following the same procedure as baseline. The center currently measures anthropometrics and blood pressure, and monitors dietary intake at the initial visit and at 3 months, so the intervention and follow up will fit within the center’s usual care protocol. Participants randomized to the DASH-4-Teens group completed a process
evaluation questionnaire at the end of the intervention. The questionnaire consisted of twelve statements describing key elements (counseling session, written materials, telephone calls) of the DASH-4-Teens intervention curriculum and process. Participants were asked to rate whether the elements were important to their understanding of the intervention or if it contributed to their success in meeting the goals of the intervention. The rating was done using a Likert scale with one being strongly disagree to five being strongly agree.

**Outcomes**

All outcome measurements were collected at baseline (at enrollment to the study) and at three months from baseline (as close to the completion of the intervention as possible). In the ongoing clinical trial, outcome measures are repeated at three months after the intervention to evaluate long-term effectiveness. Those results are not reported in the case studies.

*Anthropometrics and blood pressure* were measured using the previously described methods and equipment. The mean for both systolic and diastolic pressure from the two measurements taken at each visit were reported. Results from each of the measurements were compared. *Dietary change* was determined by comparing the random recall records from each measurement. The food recalls were analyzed using the Minnesota Nutrient Database software, and analyzed for number of fruits, vegetables and dairy products. *DASH unfriendly foods* were determined by counting the servings of foods that fit the definition of DASH “unfriendly” from the participant’s food record. *Process Evaluation* was evaluated with the questionnaire used to determine how useful
the target audience perceived the different components of the DASH intervention based on their Likert scale ratings. Knowledge and self-efficacy measures are being collected in the clinical trial at baseline, three months from baseline, and three months after the intervention. We did not feel the results would be meaningful when reported on an individual basis.

Results

A clinical trial designed by the Department of Nutrition Science at the University of Cincinnati and Cincinnati Children’s Hospital Hypertension Center is ongoing. The results presented are for the first four participants randomized to the DASH-4-Teens nutrition intervention.

Case Study 1

Participant A was a 17-year old white female. She fulfilled the requirements of the twelve week intervention by participating in ten phone calls, completed and returned twelve food records, completed three 24-hour random food recalls before attending a three-month clinic appointment where height, weight, and blood pressure readings were measured and compared to baseline readings; and by completing a process evaluation questionnaire. The participant attained 12 of 48 goals, indicating 25% compliance to DASH-4-Teens goals. It was noted anecdotally from the telephone interventionist that her food records were returned sporadically, making consistent feedback regarding her goals difficult. Her weight stayed the same from baseline to her three-month follow-up, with her height increasing by less than a centimeter. Systolic blood pressure
decreased 2 mm Hg, while diastolic increased by 7 mm Hg. Fruits and low fat dairy food consumption increased from baseline to three-months as shown in Table 4. Vegetable consumption, as well as servings of DASH unfriendly foods declined. The participant averaged a score of 3.8 for her level of engagement during telephone conversations based on the interventionist’s reaction. Based on the process evaluation, the participant rated goal setting, action plans, telephone calls, and the DASH newsletter at a 5, indicating she strongly agreed that these components of the intervention helped her meet the DASH objectives. Dietary changes that the participant thought she had made into “habits” were eating breakfast every morning and drinking more milk. At week eight of the telephone calls, she still wanted to increase vegetable servings and limit unfriendly food choices. Complete results for participant A are listed in Table 4.

<table>
<thead>
<tr>
<th>Table 4. 3-month results for Participant A</th>
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<tr>
<td><strong>Baseline</strong></td>
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<td>---------------------------------</td>
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<tr>
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<td>Blood Pressure (systolic/Diastolic mm/Hg)</td>
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<td>Vegetables (servings p/day)</td>
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<tr>
<td>Low Fat Dairy (servings p/day)</td>
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<tr>
<td>Unfriendly Foods (servings p/day)</td>
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**Case Study 2**

Participant B was a 15-year old white female. She completed the twelve-week intervention by participating in ten phone calls, completing and returning five of twelve food records, and completing three 24-hour random food recalls before attending her three-month clinic appointment. Height, weight, and blood pressure were measured and compared to baseline findings. Participant B also
completed a process evaluation questionnaire. She attained 18 of 48 goals, indicating 38% compliance to the DASH-4-Teens goals. During telephone contacts, the participant indicated to the interventionist that more goals were being attained, but it could not be confirmed due to the limited number of food records returned. Feedback in writing could not be provided due to the lack of food records. This participant’s height increased by less than a centimeter, but her weight increased by 1.2 kilograms. Systolic pressure was reduced by 18 mm Hg, while diastolic decreased by 1 mm Hg as shown in Table 5. Fruit and low fat dairy food servings increased, while vegetable and unfriendly food servings decreased. She averaged a score of 3.9 for her level of engagement during telephone conversations based on the interventionist’s reaction. Based on the process evaluation, the participant rated face-to-face counseling, goal setting, and telephone calls at a 5, indicating she strongly agreed that these components of the intervention helped her meet the DASH objectives. Changes that the participant thought she had made into “habits” by week eight of the intervention were eating more fruits and vegetables, and reading food labels. She indicated a strong desire to continue eating healthy foods. Complete results for participant B are listed in Table 5.

<table>
<thead>
<tr>
<th>Table 5. 3-month results for Participant B</th>
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<tr>
<td></td>
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<tr>
<td>Baseline</td>
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<tr>
<td>Weight (kg)</td>
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<td>Height (cm)</td>
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<tr>
<td>Blood Pressure (systolic/diastolic mm/Hg)</td>
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<tr>
<td>Fruits (servings p/day)</td>
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<td>Vegetables (servings p/day)</td>
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<tr>
<td>Low Fat Dairy (serving p/day)</td>
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<td>Unfriendly Foods (servings p/day)</td>
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</table>
Case Study 3

Participant C was a 15-year old white male. He fulfilled the requirements of the twelve week intervention by participating in ten phone calls, completing and returning twelve food records, completing three 24-hour random food recalls before attending his three-month clinic appointment where height, weight, and blood pressure readings were measured and compared to baseline readings; and by completing a process evaluation questionnaire. The participant attained 48 of 48 goals, indicating 100% compliance to the DASH-4-Teens goals. The participant decreased his weight by 1.8 kilograms, while his height stayed the same. Systolic pressure decreased by 12 mm Hg, while diastolic decreased by 7 mm Hg. Fruit and low fat dairy food servings increased, while vegetable servings were unchanged. Servings of unfriendly foods decreased. He averaged a score of 4.5 for his level of engagement during telephone conversations based on the interventionist’s reaction. Based on the process evaluation, the participant rated goal setting at a 5, indicating he strongly agreed that this component of the intervention helped him meet the DASH objectives. By the eighth week of the telephone calls, changes that the participant thought he had made into “habits” were replacing unfriendly foods with fruits and vegetables. He still wanted to make better food choices and limit portion sizes. Complete results for participant C are listed in Table 6.
Table 6. 3-Month Results for Participant C

<table>
<thead>
<tr>
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<th>Baseline</th>
<th>3-Month</th>
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</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
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<td>113.5</td>
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<tr>
<td>Height (cm)</td>
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<td>Blood Pressure (systolic/diastolic mm/Hg)</td>
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<td>Fruits (servings p/day)</td>
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<td>Vegetables (servings p/day)</td>
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<tr>
<td>Low Fat Dairy (servings p/day)</td>
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</tr>
<tr>
<td>Unfriendly Foods (servings p/day)</td>
<td>12.0</td>
<td>6.6</td>
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</tbody>
</table>

Case Study 4

Participant D was a 14-year old African American female. She completed the twelve-week intervention by participating in ten phone calls, completing and returning two modified food records, and completing three 24-hour random food recalls before returning for a three-month follow-up clinic appointment. Height, weight, and blood pressure were measured and compared to baseline findings. Participant D also completed a process evaluation questionnaire. She attained 8 of 48 goals, indicating 16% compliance to the DASH-4-Teens goals. When no food records were returned after seven phone contacts, a modified food record was provided to this participant by the telephone interventionist. The modified record was a checklist of DASH food servings. On a weekly basis, the participant could indicate compliance to DASH food goals simply by checking off servings eaten of fruits, vegetables, and low fat dairy foods. After the participant was provided with modified goal trackers, she completed and returned two trackers. The change resulted in the return of two food records. Written feedback to this participant was limited due to the lack of food records. Her height remained the same after the intervention, while her weight decreased by 4.5 kilograms. Systolic pressure was reduced by 8 mm Hg, while diastolic
decreased by 7 mm Hg. Fruit and vegetable servings increased. Low fat dairy servings remained the same, while unfriendly food consumption decreased. She averaged a score of 3.95 for her level of engagement during telephone conversations based on the interventionist’s reaction. Based on the process evaluation, the participant rated recipe and menu suggestions and keeping a food record at a 5, indicating she strongly agreed that these components of the intervention helped her meet the DASH objectives. A change that the participant thought she had made into a “habit” by week eight of the intervention was to reduce portion sizes. She still wanted to increase her servings of vegetables, but thought it might be too hard to achieve. Complete results for participant D are listed in Table 7.

<table>
<thead>
<tr>
<th>Table 7. 3-month results for Participant D</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td>Weight (kg)</td>
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<td>Height (cm)</td>
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<td>Low Fat Dairy (serving p/day)</td>
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<tr>
<td>Unfriendly Foods (servings p/day)</td>
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</tbody>
</table>

**Discussion**

The results presented are for the first four participants randomized to the DASH-4-Teens nutrition intervention. The study is ongoing. The case studies presented provide preliminary information on the acceptability and short-term effectiveness of the intervention.

Blood pressure reductions (10 mm Hg/systolic, 2 mm Hg/diastolic) experienced by the adolescents were consistent with blood pressure reductions.
(11 mm Hg/systolic, 5 mm Hg/diastolic) found in adults that participated in the DASH feeding trials and the reductions (14.2 mm Hg/systolic, 7.4 mm Hg/diastolic) found in free-living adults participating in the PREMIER Clinical Trial. The greater reductions found in the PREMIER trial could be due to the length of the interventions. The DASH-4-Teens intervention was three months in duration, while the PREIMER study provided a six month intervention.

The expectation of the DASH-4-Teens trial was that a majority of the adolescents would achieve compliance at or near 100%. Based on the limited results presented here in, the average compliance was 45% with greater compliance producing a more dramatic reduction in blood pressure. It should be noted, however that blood pressure reductions were achieved even by the participants that made small dietary changes. Family income and limited parental involvement may represent barriers to compliance; however these environmental factors were not included in the present study. Likewise, limited resources may have made access to fresh fruits and vegetables difficult. While parent information sheets and a list of discount produce and farmer’s markets were included in the DASH materials, the information may not have been shared with parents. The time of year may also impact the cost and availability of fresh produce. Farmer’s markets, a cost-effective source of fresh produce, are only open in the summer and early autumn where the study was located. The curriculum emphasized that canned or frozen fruits and vegetables were viable options to meet DASH goals, but if parents didn’t share that view compliance may have been difficult. A brief counseling session for parents might prove
beneficial, or mailing the parent information separately may insure they have access to the materials. Another factor that could impact compliance is a participant’s previous knowledge of the nutrition information presented in the DASH-4-Teens curriculum. Based on the process evaluation, the participant with 100% compliance did not find the information in the curriculum to be new; whereas the participants with lower compliance found the information to be new.

Based on the responses to the process evaluation questionnaire, participants expressed overall satisfaction with the DASH intervention. Participants rated the majority of the components as beneficial to their success with the DASH-4-Teens program. Responses to the process evaluation confirmed that the manual and activities provided appropriate information for participants to understand the DASH-4-Teens Eating Plan. The telephone and mail components were highly rated by all participants. This was expected based on the results from the behavior weight control study\textsuperscript{39} and the social and emotional development of the targeted population. Based on the adolescent’s ratings, other components integral to their success were keeping daily food records and weekly goal setting. These components are commonly used in nutrition interventions and are considered effective methods for dietary change\textsuperscript{44}.

The results and responses to the process evaluation also indicate the intervention conforms to the SCT. The reduction in blood pressure experienced by the participants indicates the curriculum and activities provided the knowledge and skills necessary for them to control their blood pressure. Self-efficacy and self-control were demonstrated by the dietary changes made throughout the
intervention. Social support was primarily achieved through the telephone interventions. Parental support was achieved on a more limited basis. This may be due to the need of adolescents to establish their independence.\textsuperscript{29} It may be a limitation of any intervention designed for this particular age group.

It is recognized that the very small number of participants make generalization of the results difficult. The racial make-up of the presented cases is consistent with the Center’s population, but the gender composition of 25% male is inconsistent with the clinic census. This could limit generalization further. The acceptability and efficacy of the intervention for the younger end of the target audience is still unknown, due to lack of representation for this age group in the four reported cases. Even with the above mentioned limitations, the results presented in the case studies provide preliminary evidence of the acceptability and efficacy of the DASH-4-Teens intervention.

**Conclusion**

Results to date support the efficacy of the DASH-4-Teens curriculum developed for this study in managing blood pressure among adolescents. The curriculum, based on sound nutrition education theory and tailored to the developmental needs of the adolescent, was easily adapted to the primary care setting. The challenge to maintain the dietary changes still remains.
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