I, Katherine L. Kampman, hereby submit this original work as part of the requirements for the degree of Master of Science in Nutrition.

It is entitled:
Comparing Different Approaches to Promoting Adherence to a DASH Diet in Adolescents with Hypertension

Student's name: Katherine L. Kampman

This work and its defense approved by:

Committee chair: Sarah Couch, PhD
Committee member: Abigail Peairs, PhD
Comparing Different Approaches to Promoting Adherence to a DASH Diet in Adolescents with Hypertension

A thesis submitted to the Graduate School of the University of Cincinnati in partial fulfillment of the requirements for the degree of Master of Science in Nutrition College of Allied Health Sciences

by

Katherine L. Kampman
B.S. Xavier University

June 2011

Committee Chair: Sarah C. Couch, PhD, RD
Abstract

Background: The Dietary Approaches to Stop Hypertension (DASH) diet is being advocated by leading health experts to treat high blood pressure in youth. The optimal intervention delivery format to promote DASH adherence in adolescents has not been ascertained.

Objective: The purpose of this thesis is to evaluate the effectiveness of the DASH-4-Teens intervention for changing diet quality, as assessed by the DASH Score and DASH Components Scores.

Methods: Sixty adolescents, ages 11-18 years, with pre-hypertension or hypertension were randomized to DASH (n=31) or RC (n=29). All participants were counseled twice by a registered dietitian on standard guidelines for blood pressure management, including the DASH diet. In addition, DASH participants received a DASH-4-Teens manual that included 10 modules describing DASH food servings, lists, tips and behavioral strategies, 15 behavioral counseling phone calls by a trained interventionist, and bi-weekly mailings. Dietary intake was assessed by 3 random 24-hour dietary recalls at baseline and 6 months. Adherence to the DASH diet was determined with an index that included 11 DASH food groups and sodium. A maximum score of 10 or 5 was assigned when a DASH component goal was met; less desirable intakes were scored proportionately. DASH component scores were summed to arrive at an overall DASH Score (0-90).

Results: In mixed effects models, DASH was a significant positive predictor of change for overall DASH score ($p<0.05$); for total grains, fruit, and sodium ($p<0.05$); and for low-fat dairy in unadjusted and adjusted models ($p<0.0001$). Change in DASH components scores for fruit, low-fat dairy and sodium were greater in DASH than RC ($p<0.05$). Post-treatment DASH
component scores for fruit, low-fat dairy, and sodium were greater for DASH compared to RC ($p<.01$).

Conclusion: These findings suggest that the greater efficacy of the DASH-4-Teens intervention over the RC currently prescribed for the treatment of adolescents with pre-hypertension and hypertension is likely related to the intensive behavioral component of the intervention. The DASH Score is a valuable tool for assessing overall dietary change and for honing in on specific dietary component challenges in hypertensive adolescents following a DASH dietary pattern.
List of Tables

Table 1...........................................................................................................................................16
Table 2...........................................................................................................................................17
Table 3...........................................................................................................................................18
Table 4...........................................................................................................................................20
Table 5...........................................................................................................................................21
I. Introduction

The adult population in the United States has experienced an increase in the prevalence of obesity, hypertension and other cardio-metabolic diseases. Much advancement has been made in the realm of adult hypertension. With the recent increase in pediatric hypertension prevalence, strategies are needed to prevent CVD risk factors from developing in these youth and tracking into adulthood. Dietary modification remains the first step in the intervention for most adults and children with hypertension. Changing dietary and lifestyle habits in the early life stages is at the crux of treating hypertension in Americans. A review of the literature related to adolescent hypertension demonstrates the reasons for concern over this situation, and shows the effectiveness of intervention strategies utilizing Dietary Approaches to Stop Hypertension (DASH). While the DASH diet shows promise for changing dietary patterns and improving blood pressures in the pediatric population, there is no established method for measuring this change and highlights the need for an index such as the DASH Score.

II. Literature Review

IIa. Primary Hypertension in Youth: Reason for Concern

Primary hypertension in childhood and adolescence is of great public concern due to its increasing prevalence and association with obesity and sedentary lifestyles, which are sharing an amplified occurrence (National High Blood Pressure Education Program, Working Group on High Blood Pressure in Children and Adolescents [NHBPEP], 2004). It is estimated that almost 5% of the pediatric population have hypertension (NHBPEP, 2004). Pediatric hypertension is easily identifiable based on the development of a large database of blood pressure norms for these life stages. For those under the age of 18, hypertension is based on three or more measurements that indicate an average blood pressure (systolic and/or diastolic) ≥95th percentile
for gender, age, and height. Pre-hypertension is defined by blood pressure levels (systolic or diastolic) that are ≥ 90th percentile and less than the 95th percentile (NHBPEP, 2004).

The concern over pediatric hypertension is reasonable considering that high blood pressure in childhood, along with poor diet, a sedentary lifestyle, and excess weight gain track into adulthood (NHBPEP, 2004). Research supports a strong association between pediatric hypertension and obesity (Lazarou, Panagiotakos, & Matalas, 2009). It is estimated that nearly 30% of obese (body mass index (BMI) > 95th percentile for age and sex) children have hypertension (Townsend, Fulgoni, III, Stern, Adu-Afarwuah, & McCarron, 2005).

Hypertension is considered to be a risk factor for cardiovascular disease (CVD) (NHBPEP, 2004, p. 28-29). In addition, type 2 diabetes, dyslipidemia and/or central adiposity, which are also CVD risk factors, are commonly found in those with pediatric hypertension (NHBPEP, 2004). Target organ damage, such as, left ventricular hypertrophy (LVH), is a complication of childhood hypertension, as it is throughout the lifecycle (NHBPEP, 2004). Changes in vasculature (increased carotid intimal-medial thickness and large artery compliance) are seen with even mild blood pressure increases and raise the risk for CVD (NHBPEP, 2004). The Fourth Report recommends echocardiograms to screen for LVH in young patients with hypertension (NHBPEP, 2004).

IIb. Dietary Recommendations for Managing CVD Risk Factors in Children

The Dietary Guidelines for Americans 2010 Report conveys that the ideal diet in childhood and adolescence provides an “adequate intake of all essential nutrients needed for growth and development, metabolism, immunity and cognitive function; and an intake of total energy (caloric) that is balanced with energy expenditure in order to maintain body weight within a healthy range” (Williams, n.d., p. 1). The Dietary Guidelines also state that a well-rounded
diet in youth should contain foods from all major food groups and reduce the risk for future chronic disease (U.S. Department of Agriculture and U.S. Department of Health and Human Services [USDA HHS], 2010). A major problem identified by many nutrition and health experts is that American children are not meeting these dietary goals. Evidence of this discrepancy is exemplified in data from the most recent National Health and Nutrition Examination Survey (NHANES), which indicate that approximately 16.9% of children and adolescents (2-19 years) are considered to be obese (body mass index (BMI) >95th percentile for sex and age) (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). In a 2010 cross-sectional study, Reedy et al. analyzed NHANES data to determine the top sources of energy for children ages 2 – 18 (Reedy & Krebs-Smith, 2010). They found that grain desserts, pizza, and soda topped the list and that almost 40% of energy consumed for these youth was in the form of empty calories (solid fats, added sugars) (Reedy & Krebs-Smith, 2010). In addition, the National Cancer Institute analyzed NHANES data from 2001 – 2004 and reported that American children and adults are consuming far less than the recommended servings of fruits, vegetables, and whole grains (National Cancer Institute [NCI], 2010). These results indicate that diets of the youth in the United States are not in line with Dietary Guidelines and are likely positive influences on weight gain and obesity.

The National High Blood Pressure Education Working Group (NHBPEWG) offers recommendations for therapeutic lifestyle changes, including dietary intervention, for children and adolescents with pre-hypertension and hypertension (NHBPEP, 2004). In part, these recommendations stem from the uncertainty regarding the long-term effects of pharmacological interventions in children (NHBPEP, 2004). While evidence to support the efficacy of lifestyle changes for lowering blood pressure in children is limited, research in the adult population serves
as the basis for the recommendations. The NHBPEP suggests that it would be expected that diet and blood pressure associations would be similar in adults and children, although this remains to be determined (NHBPEP, 2004). The long term consequences of the development of cardiovascular risk factors in childhood has prompted other organizations to publish statements and reports describing dietary and lifestyle recommendations for managing these influences. The American Heart Association has published their consensus statement, for childhood and adolescence, detailing their nutritional recommendations for the prevention of chronic heart disease in adulthood. An additional emphasis for the report is that a balanced diet for children and adolescents is intended to fulfill developmental requirements and calorie dense foods should be limited (American Heart Association [AHA], 2005). The National Cholesterol Education Program (NCEP) also published a report detailing strategies for managing CVD risk factors (mainly elevated low-density lipoprotein levels) and stressed the importance of diet therapy as the primary approach for addressing these risk factors in childhood and adolescence (NCEP Expert Panel on Blood Cholesterol Levels in Children and Adolescents [NCEP], 1992).

For prevention and management of pre-hypertension, hypertension, and other CVD risk factors, in childhood and adolescence, the NHBPEWG recommends “regular physical activity” and “a diet with limited sodium but rich in fresh fruits, fresh vegetables, fiber, and low-fat dairy; and avoiding excess weight gain”. In addition, they mention possible benefits from increases in some micronutrients, such as, potassium, calcium, magnesium, folic acid, and unsaturated fats (NHBPEP, 2004, p. 567). The AHA’s dietary suggestions are similar with added details. For example, they recommend adding baked or broiled fatty fish and eating whole grain cereals and breads instead of refined products. In addition to advice for health practitioners, they offer tips for parents and schools (AHA, 2005). The NCEP recommends a Step-Two diet for reducing
dietary saturated fat and cholesterol for youth with CVD risk factors and notes that the goal of a well-balanced diet for this life stage promotes proper growth and development, while preventing excess weight gain (NCEP, 1992). Proven long-term adherence strategies for the above recommendations and guidelines are limited, despite the strength of the scientific evidence demonstrating their efficacy.

IIc. Evidence to Support Diet and Blood Pressure Associations in Youth

Hypertensive children and adolescents may benefit from a reduced sodium diet (Sacks et al., 2001: He & MacGregor, 2006). The recommendation from the Dietary Guidelines for Americans, 2010, for all hypertensive individuals, is to reduce the amount of sodium in the diet to 1,500mg per day (U.S. Department of Agriculture and U.S. Department of Health and Human Services [USDA HHS], 2010). The current Adequate Intake (AI) for sodium is 1,500mg per day for children over the age of 8 (Panel of Dietary Intakes for Electrolytes and Water, Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board, Institute of Medicine [IOM], 2004). This intake level is adequate to cover sodium needs of the body. Researchers from the DASH-Sodium found that blood pressures were lowered when participants reduced intake to 2,300mg per day and additional reductions were achieved when intake was at 1,500mg per day (Sacks et al., 2001). In a meta-analysis of 10 controlled trials, which included 966 participants under the age of 18, He et al. found that even a modest reduction in salt intake produced a significant drop in blood pressure and would prevent the rise in blood pressure associated with age (He & MacGregor, 2006).

In an analysis of three decades of NHANES data, Townsend et al., found that low dietary intake of potassium, calcium, and magnesium were associated with higher blood pressures and other CVD risk factors (Townsend, Fulgoni, III, Stern, Adu-Afarwuah, & McCarron, 2005). The
Institute of Medicine recommends that children and adults consume at least 4,700mg per day of potassium, from food sources (fruits and vegetables) (IOM, 2004). The recommendation stems from the idea that intake at this level poses no risk, as excess is excreted. Also, 4,700mg per day is a similar amount to that of a DASH dietary pattern and to what has shown promising results in trials investigating the relationship (Appel LJ and American Society of Hypertension Writing Group [Appel], 2009). Potassium helps to reduce overall body sodium by promoting excretion of the mineral. It may also promote vascular smooth muscle cell relaxation, thereby, reducing peripheral resistance (Gropper, Smith, & Groff, 2009). Simons-Morton et al. conducted a major review of observational and intervention studies which included an investigation into the relationship between potassium intake and hypertension in children and adolescents. Their findings lead them to the conclusion that while results of the studies were mixed, there does appear to be a significant relationship between higher potassium intakes and lower blood pressures (Simons-Morton & Obarzanek, 1997).

Some researchers suspect that higher levels of calcium intake help to mediate hypertension by promoting relaxation of vascular smooth muscle cells (Gropper et al., 2009). There is inconclusive evidence to support an inverse association between calcium intake and blood pressure levels in hypertensive adults. However, Moore et al. found that children who consumed 2 or more servings of dairy per day, during preschool years, had lower blood pressures in early adolescence. The effect was even greater for those who consumed 2 or more servings of dairy foods per day combined with 4 or more servings of fruits and vegetables (Moore et al., 2005).

There is also support for the idea that increased magnesium intake may help to lower blood pressure by promoting the relaxation of vascular smooth muscle cells (Gropper et al.,
Recent research in adult patients with diabetes and hypertension found that high levels of magnesium supplementation improved vascular function (Barbagallo, Dominguez, Pineo, & Belvedere, 2010). In 2008, Couch et al. reported that adolescents following a DASH-type diet had increased magnesium intake, amongst other beneficial dietary factors, and lower blood pressures. The independent effect of magnesium change on blood pressure in this study was not determined (Couch et al., 2008).

As part of their recommendations for therapeutic lifestyle changes for children and adolescents with hypertension, the NHBPEWG offers these dietary modification suggestions: portion control, limited sugary beverages and energy-dense snacks, increased fresh fruit and vegetable consumption, decreased sodium, increased fiber, low-fat dairy foods, regular meals, and eating breakfast (NHBPEP, 2004, p. 566). These recommendations are in line with the basis of the Dietary Approaches to Stop Hypertension (DASH) eating plan. The DASH eating plan was originally developed for the prevention and treatment of hypertension in adults and has had success in clinical trials for improving blood pressures in pre-hypertensive and hypertensive adults (NHBPEP, 2004).

Moore et al. studied data from the longitudinal Framingham Children’s Study and found that children who consumed “DASH-type” diets including 4 or more servings of fruits and vegetables and 2 or more servings of dairy products had better blood pressure levels than those who consumed less (Moore et al., 2005). Recently, clinical trials have investigated and support the efficacy of the DASH diet in children and adolescents with elevated blood pressure (Couch et al., 2008: Gunther et al., 2009). After reporting promising results from a short-term (3 months) nutrition intervention investigating the efficacy of a “DASH-type” diet for adolescents, researchers developed the DASH-4-Teens intervention (Couch et al., 2008).
DASH-4-Teens is an ongoing randomized controlled clinical trial started in 2007 in which adolescents (11-18 year olds) with pre-hypertension or hypertension are assigned to one of two intervention groups. For 24 weeks, participants follow either the DASH-4-Teens program or routine nutrition education recommended by the National High Blood Pressure Education Program. The DASH-4-Teens intervention group receives individualized in-person and telephone counseling and mailings. Their diet is high in fruits, vegetables, and low-fat dairy foods. It is low in fat and sodium. The routine care group will receive individual counseling in line with recommendations of the Fourth Pediatric Report of the National High Blood Pressure Education Program. Among other outcomes (blood pressure, vascular function, dietary intake), adherence to the treatment will be measured at 6 months and 1 year (follow-up). Researchers hypothesize that the DASH-4-Teens will have greater improvements in diet quality, blood pressure, and vascular function as compared to those in the routine care group. The purpose of this trial is to address the gap in research related to the effectiveness of a DASH diet for hypertension in the adolescent life stage (Couch, 2007).

II.d. Novel Dietary Assessment Measures to Examine Changes in Dietary Patterns

Current nutrition guidelines stress the importance of making food group changes and overall dietary pattern modifications, instead of focusing on single nutrient changes. Studies examining dietary pattern changes in response to new guidelines require assessment methods that allow measurement of change in overall diet quality and degree of adherence to current guidelines. On a national level, the USDA developed the Healthy Eating Index (HEI). This is a measure of overall diet quality for the United States population. Prior to the development of the HEI, only individual diet components, such as, fat and cholesterol were measured. The HEI is a scoring system that provides a quantitative measure of how well Americans are adhering to the
recommendations of The Dietary Guidelines for Americans or the Food Guide Pyramid (US Department of Agriculture, Center for Nutrition Policy and Promotion [USDA], 2006). Another scoring system, called KIDMED has been used successfully to assess children’s adherence to the Mediterranean diet (Lazarou, Panagiotakos, & Matalas, 2009). KIDMED is comprised of 16 components representing the principles of the Mediterranean diet (Lazarou et al., 2009). Researchers found that children with better KIDMED scores were less likely to have elevated diastolic blood pressures (Lazarou et al., 2009). In the present study, the DASH Score is being used to measure overall diet quality change and adherence to the interventions of the DASH-4-Teens trial.

The DASH Score is a novel way to assess overall diet quality, change in individual component food groups, and adherence to the DASH diet. The DASH Score has been used successfully in previous trials (Gunther et al., 2009; Folsom, 2007). Gunther et al. studied youth (10 to 22 years) with Type 1 and Type 2 diabetes and needed a way to measure adherence to the DASH diet. They employed a DASH Score comprised of 8 component categories (grains, vegetables, fruit, dairy, meat, nuts/seeds/legumes, fats/oils, and sweets) (Gunther et al., 2009). Goals for each component were assigned to participants according to energy requirements. Participants were given a maximum score of 10 for each component in which the goal was met. When the goal for a component was not achieved, it was scored proportionately. The individual component scores were then totaled for a total DASH Score ranging from 0 to 80, with 80 indicating total adherence to the DASH diet (Gunther et al., 2009). Researchers found that a greater adherence to DASH and a greater overall DASH Score was inversely related to blood pressures in participants with Type 1 diabetes. While the DASH Score was shown to be a valuable tool for measuring DASH diet adherence in the Gunther et al. study, a noted weakness
in the measure was that it did not assess sodium intake (Gunther et al., 2009). Sodium was not a component of the original DASH Score because dietary intake was collected using food frequency questionnaires (FFQ), which are somewhat unreliable for estimating sodium intake (Gunther et al., 2009). As discussed earlier, sodium restriction is an important part of diet changes for those with hypertension. In the current DASH-4-Teens trial, a sodium component has been added in the calculation of the DASH score. Therefore, the overall DASH score ranges from 0 to 90, with 90 indicating total adherence to the DASH diet.

The DASH eating pattern has become the focus of much research and has been used in several clinical trials. Despite the fact that the DASH eating pattern is designed to bring about an overall dietary pattern change in the user, there is a lack of research on how to assess this change. Much of the research to date related to DASH intervention work and dietary outcomes has focused on changes in particular food groups, such as fruit and vegetable consumption (Moore et al., 2005; McCall et al., 2009). Others have chosen to focus on particular nutrient changes in response to a DASH intervention such as; sodium, potassium, or calcium (He & MacGregor, 2006; Townsend et al., 2005). A change in one’s overall diet quality emphasizing fruits, vegetables, low-fat dairy foods, lean protein sources, and low-sodium foods appears to be the key to the successful management of pediatric hypertension as it is for adult hypertension. Dietary changes made early in life contribute to a lifetime of better health and reduced risk factors for many chronic diseases. It is reasonable to hypothesize that if the overall diet quality is changed toward a DASH dietary pattern, the result will be improvements in blood pressure.
III. Purpose, Research Question, and Major Hypothesis

IIIa. Purpose

The purpose of this thesis is to research the effectiveness of the DASH-4-Teens intervention for changing diet quality, as assessed by the DASH Score and DASH Component Scores.

IIIb. Research Question

In adolescents with pre-hypertension and hypertension, does the DASH-4-Teens intervention improve overall diet quality, as measured by the DASH Score and DASH Components Scores, more than routine nutrition care for managing blood pressure?

IIIc. Major Hypothesis

Adolescents who participate in the DASH-4-Teens intervention will have a greater improvement in DASH Score and DASH Component Scores for fruits and vegetables and low-fat dairy foods, after the 24-week trial, as compared to the adolescents receiving the routine nutrition education recommended by the National High Blood Pressure Education Program.

IV. Methods

IVa. Participants

The study participants took part in the DASH-4-Teens clinical trial between February 2008 and November 2010. Adolescents, ages 11 to 18 years, with a diagnosis of prehypertension or hypertension were recruited from the Cincinnati Children’s Hypertension Center (CCHC), for participation in the study. Hypertension status was based on the criteria established by the Fourth Pediatric Report on Hypertension which defines pediatric prehypertension as an average systolic blood pressure (SBP) or diastolic blood pressure (DBP) ≥90th percentile and < 95th percentile for age, gender, and height and hypertension as an average SBP
or DBP $\geq 95^{th}$ percentile but $< 99^{th}$ percentile $+ 5$ mm Hg based on gender, age, and height, as measured on 3 or more occasions (NHBPEP, 2004). The subset of participants for this thesis was comprised of 31 participants randomized to the 24-week DASH-4-Teens intervention group (DASH) and 29 randomized to the Routine Care (RC) group.

Study exclusion criteria included stage 2 hypertension status ($BP > 99^{th}$ percentile $+ 5$ mm Hg), secondary hypertension, use of anti-hypertensive medications, prior exposure to formal dietary therapy to manage BP, target organ damage, Type 1 or 2 Diabetes, presence of an eating disorder, and any psychological or medical conditions that would prevent full participation. Adolescents were also excluded for use of BP altering medications, and unwillingness to stop the use of vitamins, minerals, and certain antacids. Potential participants had to be English speaking and had to have full medical clearance from a physician to participate. Adolescents under the age of 18 years signed informed assent forms and a parent signed a parental permission form and adolescents 18 years of age and older signed informed consent forms, prior to participation in the study. The study was approved by the Cincinnati Children’s Hospital Medical Center (CCHMC) Institutional Review Board and the University of Cincinnati Institutional Review Board.

IVb. Intervention

The DASH intervention design was based on the principles of the Social Cognitive Theory to enhance the effects of the DASH eating pattern for lowering blood pressure and to encourage sustained dietary behavior change. DASH is a diet, originally developed for adults with hypertension and was shown to be effective for lowering blood pressures without weight loss. The DASH eating pattern emphasizes fruits, vegetables and low-fat dairy foods, whole grains, poultry, fish, and nuts. Reductions in fats, red meat, sweets, and sugar-containing beverages are also encouraged (Svetkey et al., 1999). For the DASH group participants of the
DASH-4-Teens study, researchers employed a behaviorally based curriculum to encourage adherence to the DASH eating pattern.

Participants in the DASH treatment group were given an illustrated manual detailing the tenets of the DASH diet. In the manual were recommendations for appropriate calorie levels and serving sizes for each food category (grains, vegetables, fruit, dairy, meat, and nuts/seeds) based on participants’ gender, age, and activity level. Activities, recipes, and tips were included to encourage the gradual incorporation of fruits, vegetables, whole grains, lean meats, low-fat dairy, low sodium foods, and low fat foods into their diets to achieve individual goals. Limitation and examples of “DASH Unfriendly” foods (> 3 grams of fat and 480mg of sodium per serving) were explained. Behavioral strategies emphasized included: food monitoring, goal setting, problem solving, managing social situations and planning for long-term maintenance.

Over the course of the 24-week intervention, DASH subjects participated in 2 individual counseling sessions (baseline and 12 weeks) and 14 telephone conversations (weekly for weeks 2 – 10, then bi-weekly) with a Registered Dietitian that focused on behavioral strategies to enable the adoption of the DASH diet at home and elsewhere. They also received mailings of additional manual sections that coincided with topics addressed by the dietitians in telephone conversations such as, meal planning and social support.

DASH teens were trained to use food trackers for 5 days of each week of the trial. On each food tracking form, the participants noted the numbers of servings of fruits, vegetables, low-fat dairy, and “DASH unfriendly” foods they ate. Each adolescent had the potential to earn a total of $200 over the 24-week intervention period based on their compliance with the tracking and by meeting their goals, as assessed by the study dietitians. The food tracking system was devised to encourage study participation, compliance with the DASH eating pattern, and to help
identify problem foods. This information was not used to assess dietary outcomes for this study, as it was self-reported by the participants and may have included some inaccuracies.

Adolescents randomized to the RC group were provided with nutrition counseling typically given to all newly diagnosed hypertensive patients at the CCHC. This type of counseling is in line with the recommendations set forth by the Fourth Pediatric Report of the National High Blood Pressure Education Program. Each received a booklet called *Your Guide to Lowering Blood Pressure* which discusses the importance of increasing fruit and vegetable consumption and decreasing fat and sodium and recommends a DASH-type diet (US Department of Health and Human Services, National Institutes of Health, National Heart, Lung, and Blood Institute, 2003). Weight loss and weight loss tips were suggested for overweight adolescents, although these were not individualized. Practical information was offered on how to change eating habits and lower blood pressure.

RC participants received 2 individual counseling sessions with a Registered Dietitian, in which dietary recommendations were reviewed and dietary deficiencies and excesses were addressed, at baseline and week 12. Consistent with routine care at CCHC, behavioral skills and strategies were not addressed.

IVc. Outcome Measures

Demographic and Anthropometric

Adolescents self-reported date of birth, gender, and ethnicity. At baseline and six months, height and weight were measured at the CCHC by trained nursing personnel. Height was measured using a wall-mounted stadiometer and weight was measured using a calibrated triple-beam balance scale. The average of 2 readings were used to calculate body mass index (BMI) calculated as weight in kilograms divided by the square of height in meters. BMI z-scores
were used as a covariate in the statistical analysis. They were calculated using Centers for Disease Control growth charts which contain age-specific median, standard deviation, and distribution skewness correction information by the LMS method (Cole, Freeman, & Preece, 1998).

Dietary

Dietary intake data was collected at both baseline and six months. At each time period, three random, 24-hour recalls were collected from each participant using the multi-pass method, over a two week time period. Trained research dietitians from the Cincinnati Center for Nutrition Research (CCNR) at Cincinnati Children’s Hospital Medical Center, performed the recalls during telephone interviews with the adolescents. Participants were trained in reliable portion size estimation methods, prior to the recalls. The recalls were collected and analyzed using the Minnesota Nutrient Data Systems (NDS) software. Study dietitians then coded and analyzed each entry for calories, nutrient content, number of fruit, vegetable, and low-fat dairy servings and high fat and high sodium foods.

The DASH Score

Averages were calculated for each (baseline and six months) set of three 24-hour dietary recalls. The resulting data was used to calculate the DASH Score for each participant, for baseline and six months. This dietary index was used to measure the overall dietary change between baseline and six months for each group. In doing so, the DASH Score was also a measure of how well the DASH group adhered to the DASH eating pattern and the overall effectiveness of each treatment. The DASH Score was comprised of 11 component scores (total grains, whole grains, vegetables, fruits, total dairy, low-fat dairy, meat/poultry/fish/eggs, nuts/seeds/legumes, fats/oils, sweets, and sodium). The DASH Score used by Gunther et al. had
one component for grains and one for dairy. Each had a maximum score of 10 (Gunther et al., 2009). For the DASH-4-Teens DASH Score, the grain component was divided into total grains and whole grains and the dairy component divided into total dairy and low-fat dairy. Therefore, each component had a maximum score of 5. The DASH dietary pattern emphasizes the intake of whole grains and low-fat dairy. Thus, DASH-4-Teens researchers highlighted that importance by dividing up the component scores for these components. For the remaining categories, a maximum score of 10 was achieved when the recommended intake goals were met. When goals were not achieved, intake was scored proportionately. The resulting component scores were totaled to create an overall DASH Score, which ranged between 0 and 90.

Table 1. The DASH Score component scores and the standards for minimum and maximum scores per calorie level.

<table>
<thead>
<tr>
<th>Participant Calorie Level</th>
<th>Maximum Score</th>
<th>Daily Intake Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>For Maximum Score</td>
<td>For Minimum Score of 0</td>
</tr>
<tr>
<td></td>
<td>1600kcal</td>
<td>1800kcal</td>
</tr>
<tr>
<td>Grains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
<td>≥6</td>
</tr>
<tr>
<td>Whole</td>
<td>5</td>
<td>≥50%</td>
</tr>
<tr>
<td>Vegetables</td>
<td>10</td>
<td>≥4</td>
</tr>
<tr>
<td>Fruits</td>
<td>10</td>
<td>≥3</td>
</tr>
<tr>
<td>Dairy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
<td>≥3</td>
</tr>
<tr>
<td>Low-Fat</td>
<td>5</td>
<td>75%</td>
</tr>
<tr>
<td>Meat, poultry, fish, eggs</td>
<td>10</td>
<td>≤2</td>
</tr>
<tr>
<td>Nuts, seeds, legumes</td>
<td>10</td>
<td>≥.5</td>
</tr>
<tr>
<td>Fats, oils</td>
<td>10</td>
<td>≤2</td>
</tr>
<tr>
<td>Sweets</td>
<td>10</td>
<td>≤1</td>
</tr>
<tr>
<td>Sodium</td>
<td>10</td>
<td>≤2300mg</td>
</tr>
</tbody>
</table>

Data are as servings per day unless otherwise noted.
Proportionate scores were assigned to those intakes falling between minimum and maximum levels.

DASH Score component goals for each participant were based on recommendations specified by the Dietary Guidelines for Americans (US Department of Health and Human Services, US Department of Agriculture, 2005) and the DASH Collaborative Research Group (Karanja et al., 1999) and on calorie levels specific for age and gender, as indicated in Table 2. These levels are consistent with the Dietary Reference Intakes for males and females, ages 11-18.
years, for energy, macronutrients, micronutrients, and fiber (Panel on Macronutrients, Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board, Institute of Medicine [DRI], 2005). The assigned calorie levels were based on a sedentary activity level and calculated to achieve weight maintenance.

**Table 2. Calorie Levels by Gender and Age**

<table>
<thead>
<tr>
<th>Age Ranges in Years</th>
<th>Female</th>
<th>Age</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-13</td>
<td>1600kcal</td>
<td>1800kcal</td>
<td>1800kcal</td>
</tr>
<tr>
<td>14-18</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

IVd. Statistical Analysis

Subjects included in these analyses were study completers (those with baseline and post-treatment, e.g, 6-month data). Means and standard deviations were derived at baseline and post-treatment for continuous variables and frequencies for categorical variables. Distributions of the residuals were checked for normality assumptions and based on these findings, all DASH component scores, but not the overall DASH score, were determined to be non-normally distributed. Independent sample t-tests were used to compare intervention groups for continuous baseline subject characteristics, and baseline and post-treatment BMI z-score, energy intake and overall DASH score; chi-square tests were used to determine group differences for baseline categorical subject characteristics; and the Wilcoxon Rank Sums Procedure was used to compare intervention groups for pre and post-treatment DASH component scores. Mixed effects models were used to assess relationships between change in total DASH score (baseline to post-treatment) and intervention, and the non-parametric test QUANTREG was used to assess the relationships between changes in DASH component scores (baseline to post-treatment) and intervention. Final models were adjusted for age, gender, race, BMI z-score and energy.
Statistical analyses were performed with SAS software (version 9.2, SAS Institute, Cary, North Carolina. P values <0.05 were considered to be statistically significant.

V. Results

Va. Baseline Demographics, BMI z-score, and Energy

At baseline, there were no significant differences between the DASH and RC groups for age, gender, race, BMI z-score, or energy intake (Table 3). The differences in family income between the groups were significant. The DASH group had significantly fewer participants in the $20,000 to $50,000 income per year category and the RC group had significantly fewer participants in the $50,000 to $80,000 income per year category.

### Table 3. Mean values (SE) and number (n, %) of demographic characteristics and BMI z-score, and energy at baseline for 60 randomly assigned participants, by dietary condition.

<table>
<thead>
<tr>
<th></th>
<th>DASH (n=31)</th>
<th>RC (n=29)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age, years (SE)</strong></td>
<td>14.65 (0.38)</td>
<td>14.52 (0.36)</td>
</tr>
<tr>
<td><strong>Gender, n (%)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>20 (64.52)</td>
<td>18 (62.07)</td>
</tr>
<tr>
<td>Females</td>
<td>11 (35.48)</td>
<td>11 (37.93)</td>
</tr>
<tr>
<td><strong>Race, n (%)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>15 (48.39)</td>
<td>19 (65.52)</td>
</tr>
<tr>
<td>Black</td>
<td>16 (51.61)</td>
<td>10 (34.48)</td>
</tr>
<tr>
<td><strong>Family Income, n (%)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;$20,000</td>
<td>8 (26.67)</td>
<td>6 (22.22)</td>
</tr>
<tr>
<td>$20,000-$50,000</td>
<td>6 (20.00)</td>
<td>13 (48.15)</td>
</tr>
<tr>
<td>$50,000-$80,000</td>
<td>8 (26.67)</td>
<td>1 (3.70)</td>
</tr>
<tr>
<td>$80,000+</td>
<td>8 (26.67)</td>
<td>7 (25.93)</td>
</tr>
<tr>
<td><strong>BMI z-score (SE)</strong></td>
<td>1.79 (0.15)</td>
<td>1.95 (0.17)</td>
</tr>
<tr>
<td><strong>Energy, kcal/day (SE)</strong></td>
<td>1655 (85)</td>
<td>1763 (124)</td>
</tr>
</tbody>
</table>

*Family Income data missing from DASH (n=1) and RC (n=2)

* Difference between groups P <0.05
Vb. Comparison between intervention groups for baseline and post-treatment overall DASH Score, DASH component scores, and energy.

Table 4 shows a comparison of intervention group means for overall DASH Score, DASH component scores, and energy. There were no significant differences between groups at baseline for any of these dietary variables. In general, the overall DASH Score at baseline was moderate at 43% versus 44% of the maximum possible score for DASH versus RC participants, respectively. Post-treatment, the DASH group improved in the overall unadjusted DASH Score to 54% of the maximum possible score, while RC dropped from 44% to 43% of the maximum score. Unadjusted post-treatment DASH component scores for fruit, low-fat dairy, and sodium were significantly greater for DASH participants compared to RC participants ($p<0.01$). There was a trend for unadjusted post-treatment DASH component scores for total dairy to be greater in the DASH group relative to the RC group ($p<0.10$). Mean energy intake increased, non-significantly, in both DASH and RC from baseline to post-treatment. The difference between the two groups for energy intake, post-treatment, was not significant.
In mixed effects models predicting the change in overall DASH Score (Table 5), the DASH intervention unadjusted (model 1), adjusted for race, gender, and income (model 2), and adjusted for model 2 confounders plus BMI z-score and energy (model 3) was a significant positive predictor of change in overall DASH Score from baseline to post-treatment. The unadjusted model results for the sweets component indicate that the DASH intervention was a positive predictor of change ($p<0.05$). In the unadjusted (model 1) and partially adjusted (model 2) quantile regression models, the DASH intervention was a significant positive predictor of

### Table 4. Mean (SE) Overall DASH Score, DASH Component Scores, and energy, for DASH and RC at Baseline and 6 Months.  

<table>
<thead>
<tr>
<th></th>
<th>DASH Baseline</th>
<th>DASH 6 Months</th>
<th>RC Baseline</th>
<th>RC 6 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall DASH Score</strong></td>
<td>38.49(1.50)</td>
<td><strong>48.11(1.81)</strong></td>
<td>39.61(1.99)</td>
<td><strong>38.43(2.15)</strong></td>
</tr>
<tr>
<td><strong>DASH Component Scores</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grains</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>3.98(0.14)</td>
<td>3.45(0.23)</td>
<td>3.48(0.22)</td>
<td>3.64(0.17)</td>
</tr>
<tr>
<td>Whole</td>
<td>1.66(0.21)</td>
<td>1.81(0.21)</td>
<td>1.33(0.23)</td>
<td>1.86(0.27)</td>
</tr>
<tr>
<td>Vegetables</td>
<td>2.95(0.35)</td>
<td>3.70(0.47)</td>
<td>3.57(0.34)</td>
<td>4.26(0.38)</td>
</tr>
<tr>
<td>Fruits</td>
<td>3.09(0.53)</td>
<td><strong>5.45(0.63)</strong></td>
<td>3.57(0.59)</td>
<td>2.64(0.57)</td>
</tr>
<tr>
<td>Dairy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2.53(0.21)</td>
<td><strong>3.29(0.23)</strong></td>
<td>2.87(0.27)</td>
<td>2.90(0.26)</td>
</tr>
<tr>
<td>Low-Fat</td>
<td>1.06(0.25)</td>
<td><strong>2.69(0.27)</strong></td>
<td>1.56(0.28)</td>
<td>1.29(0.29)</td>
</tr>
<tr>
<td>Meat, poultry, fish, eggs</td>
<td>5.35(0.45)</td>
<td>6.32(0.59)</td>
<td>5.53(0.55)</td>
<td>4.91(0.58)</td>
</tr>
<tr>
<td>Nuts, seeds, legumes</td>
<td>0.77(0.32)</td>
<td>1.02(0.37)</td>
<td>1.62(0.41)</td>
<td>1.14(0.38)</td>
</tr>
<tr>
<td>Fats, oils</td>
<td>7.06(0.42)</td>
<td>7.46(0.48)</td>
<td>6.51(0.46)</td>
<td>6.60(0.52)</td>
</tr>
<tr>
<td>Sweets</td>
<td>4.58(0.50)</td>
<td>6.32(0.69)</td>
<td>4.17(0.59)</td>
<td>4.48(0.63)</td>
</tr>
<tr>
<td>Sodium</td>
<td>5.45(0.49)</td>
<td><strong>6.59(0.61)</strong></td>
<td>5.38(0.57)</td>
<td>4.70(0.54)</td>
</tr>
<tr>
<td><strong>Energy, kcal/day (SE)</strong></td>
<td>1655(85)</td>
<td>1830(85)</td>
<td>1763(124)</td>
<td>2016(124)</td>
</tr>
</tbody>
</table>

Significance level testing condition differences at baseline and post-treatment obtained by quantile regression analysis and adjusted for race, gender, income, BMI z-score, and energy.

† Comparison of post-treatment means, $p<0.10$.
* Comparison of group means post-treatment, $p<0.01$.

Overall DASH Score range: 0=lowest, 90=highest.

Total grains, Whole grains, Total dairy, Low-fat dairy score range: 0=lowest, 5=highest.

Vegetables, Fruits, Meat, Nuts, Fats, Sweets, Sodium score range: 0=lowest, 10=highest.

Meat, Fats, Sweets, Sodium: a higher score = lower intake.
change in DASH component scores for total grains and fruit. However, once adjusted for energy and BMI z-score, these differences no longer reached significance. In all three models, the DASH intervention was a significant positive predictor of change in the DASH component score for low-fat dairy from baseline to post-treatment. Additionally, the DASH intervention adjusted for demographics, BMI z-score, and energy was a positive predictor of change in the DASH component score for sodium.

<table>
<thead>
<tr>
<th>Table 5. Change in overall DASH Score and DASH component scores from baseline to post-treatment with DASH intervention as predictor of change.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DASH Score</strong></td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>DASH Component Scores</td>
</tr>
<tr>
<td>Grains</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Whole</td>
</tr>
<tr>
<td>Vegetables</td>
</tr>
<tr>
<td>Fruits</td>
</tr>
<tr>
<td>Dairy</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Low-Fat</td>
</tr>
<tr>
<td>Meat, poultry, fish, eggs</td>
</tr>
<tr>
<td>Nuts, seeds, legumes</td>
</tr>
<tr>
<td>Fats, oils</td>
</tr>
<tr>
<td>Sweets</td>
</tr>
<tr>
<td>Sodium</td>
</tr>
</tbody>
</table>

*Model 2 data are adjusted for race, gender, and income.
*Model 3 data are adjusted for race, gender, income, BMI z-score, and energy.
*Insufficient data available for analysis of this category.
VI. Discussion

In this study, the DASH Score was used to measure change in overall diet quality and individual dietary components in an adolescent population following a dietary intervention to lower blood pressure. Sixty adolescents were randomized to follow either the DASH dietary pattern (n=31) or RC (n=29) for hypertension and pre-hypertension management. The primary interest in the DASH-4-Teens intervention in this particular study was to determine whether or not adolescents would adhere more to DASH dietary guidelines when they were provided with behavioral change components, as given to the DASH-4-Teens treatment group, compared to a group that did not get this skill building information (e.g. RC). This study provides evidence that the DASH 4-Teens intervention was more effective than routine care in promoting adherence to a DASH dietary pattern. Overall DASH score significantly improved from 43% of the maximum possible DASH score to 54% of the maximum score in the DASH group. This compared to no improvement in DASH Score among the RC group. It stands to reason that in the real life setting of a hypertension clinic, the RC currently provided to hypertensive adolescents may be inadequate for encouraging DASH dietary change and thereby lowering blood pressures.

No research has focused on the measurement of dietary pattern change in adolescents with hypertension following implementation of a program designed to promote current guidelines advocating a DASH dietary pattern to lower blood pressure. As a means of addressing this void, the current study used a dietary index (the DASH Score) to measure this change. A recent observational study examined the association between adherence to the DASH diet and hypertension prevalence in youth with diabetes and found an inverse relationship between a greater adherence to the DASH dietary pattern (as evidenced by a higher DASH
Score) and prevalence of hypertension (Gunther et al., 2009). Lazarou et al. also addressed the shortage of research in this area by examining the association between adherence to a Mediterranean diet, physical activity and blood pressure in a population of youth with hypertension. Greater adherence to the Mediterranean diet (a higher KIDMED score) was associated with lower blood pressures (Lazarou et al., 2009). These study results highlight the need for a scoring system of this sort to measure adherence to the DASH diet in youth with hypertension. Heretofore, this has not been done.

The uniqueness of the DASH diet is that it is designed so that all of the individual dietary components purported to lower blood pressure, e.g. potassium, calcium, magnesium, are maximized in the suggested dietary pattern and consumed daily to allow the nutrients to work synergistically, to optimally lower blood pressure. The DASH Score, in addition to measuring the overall adherence to a DASH dietary pattern, can highlight areas in the diet that need improvement and those that have improved over time. For example, in this study, it was found that DASH participants were able to improve their fruit intake in the 6 month trial period. The average fruit component score improved by almost two and a half points in 6 months, indicating more fruit intake for the period. However, the average vegetable component of the DASH Score improved by less than a point in 6 months, for the DASH group. Fruit and vegetable intake improvement in this age group has been an ongoing challenge for clinicians; indicating an area for future focus.

Investigation into the barriers to meeting current fruit and vegetable intake goals in the general U.S. population reveal that for low income families, the price of fresh produce is inhibitory (Cassidy, Jetter, & Culp, 2007). In this study, more than half of those that reported family income had an income of less than $50,000 per year and almost 25% had a family income
of $20,000 per year or less. Recognizing that income is an important and potentially influencing factor on DASH dietary adherence, this demographic variable was adjusted for in the final analysis of this study. Adjusting for income did not appear to significantly modify the findings regarding the effect of the DASH intervention on fruit and vegetable intake. Nevertheless, income may have been one of the factors contributing to lower fruit and vegetable component scores, overall, in both groups. The dietary intake behaviors of adolescents in this study may have been affected by other factors including: foods available at home and school, parental and peer intake and preferences, individual taste preferences, and perceptions of healthy eating. Recognizing a shortage in research related to these behaviors and behavior change methods, Pearson et al. (2011) focused a 2-year study on the association of individual, social, and environmental factors and the change in fruit, vegetable and energy-dense snack consumption in an adolescent population. Their findings suggest that self-efficacy for healthy eating and availability of these foods at home are the best determinants of dietary change and that interventions addressing these factors may produce greater behavior change and greater improvement in overall diet quality (Pearson, Ball, & Crawford, 2011).

BMI z-score was used in this study to describe the height and weight relationship of the study subjects. Most of the participants were over-weight or obese and their measurements were outside of the reference data, e.g. greater than the 85% for their age group. It is likely that the participants’ weight and lifestyle factors affected their overall calorie intake and food choices. Interestingly, the present study found that both the DASH group and the RC group in the DASH-4-Teens trial increased their caloric intake over the 6 month period. This suggests that the adolescents were getting the message to increase the intake of certain foods (“DASH friendly”) but had a more difficult time eliminating the “DASH unfriendly” foods. Also in mixed models,
BMI z-score and energy intake appeared to be significant confounders in relationships between the intervention group and change in fruit and total grains intake. This is evidenced by the fact that when BMI z-score and energy were added to the models, significant differences between groups for intervention effect on change in fruit and total grains disappeared. This suggests that in both groups, participants’ weight status and energy intake contributed to changes in intake of fruits and grains, e.g. greater BMI z-score, greater change in intake of fruits. An unexpected finding in this study was that the DASH group significantly \( (p<0.05) \) reduced their intake of total grains while the RC group actually showed a small increase in this component. This suggests that the DASH group may have been taking care to reduce their intake of some “DASH unfriendly” foods, as evidenced by the significant improvement in the sweets component score \( (p<0.05) \); however they did not replace these items with healthier whole grain foods, as demonstrated by the lack of change in the whole grain component score for DASH. These observations are consistent with findings of the Pearson et al. study, in which, researchers found that overall, the adolescent participants had a higher self-efficacy value for increasing fruit intake than they did for decreasing junk food intake (Pearson et al., 2011). Future interventions may benefit from placing a heavier emphasis on reducing intake of low nutrient quality foods and replacing them with fruits, vegetables and more nutrient dense foods.

In a separate study, researchers for the DASH-4-Teens intervention are collecting data regarding the school food environment and the impact it has on dietary intake. Many of the participants in this study received free or reduced price lunches at school which included a choice of 2 fruits or vegetables. It appears as though the participants were not taking advantage of these offerings as evidenced by their inability to meet fruit and vegetable goals, at times. Similarly, researchers in California investigated the school food environment in low-income
neighborhoods and schools and the effect of this variable on dietary intake. They found that while the adolescents in the study thought it was important to have healthy foods available at school, they did not perceive the offerings at their schools to be healthy. While the students were likely to consume healthy foods when they were served, they also purchased and consumed unhealthy foods, if they were available at the school (Gosliner, Madsen, Woodward-Lopez, & Crawford, 2011). More intensive behavioral intervention focused on choices made in the lunchroom and overcoming negative peer and unhealthy food marketing influences may lead to healthier eating at school. This research also highlights the need for improving school lunches by not only offering healthier options, but reducing the availability of unhealthy options. It may be beneficial to participants of future DASH-4-Teens interventions to have more information on handling barriers to fruit and vegetable consumption at school, included in the education component of the study.

The findings of this study provide support that the moderate intensity, telephone based, DASH-4-Teens intervention resulted in modest dietary change. This is exemplified in the significantly higher DASH component scores (as compared to those of RC) for low-fat dairy, fruit and sodium. Minor improvements were seen in other important food component categories for the DASH group as the change in scores for total and whole grains, sweets, lean meats, and fats/oils categories were greater for DASH participants, however the differences between DASH and RC were not significant. These findings also suggest that a more intensive behavioral intervention may produce even greater change in DASH Score, diet, and blood pressure. Additional follow-up studies on the participants in the DASH-4-Teens intervention will examine the relationship between DASH food component score changes and blood pressure.
A limitation of this study involves the use of 24 hour dietary recalls. Recall bias is usually a concern in studies that employ the use of 24 hour food recalls. While the use of the multi-pass method improves the value of the dietary information collected, there was still the potential for unintentional memory lapses. This population may also have been more likely to over-report or under-report foods or to provide information that they thought would appear more desirable to adult researchers, which may have led to some respondent bias. The size of the sample used for this analysis is a limitation of this study. The DASH-4-Teens intervention is an ongoing study and is continuing to recruit participants and gather data. Additional assessments of dietary change using the DASH Score at the end of the DASH-4-Teens intervention, would include a larger sample and may help to strengthen these results, highlight additional areas for improvement, and provide more support for the use of the DASH Score for measuring dietary change.

VII. Conclusion

In conclusion, there appears to be an advantage to the use of the DASH-4-Teens intervention over the RC currently prescribed for the treatment of adolescents with pre-hypertension and hypertension. The DASH Score is a novel and valuable tool for assessing overall dietary change in the adolescent hypertensive population participating in dietary intervention. It is also useful for honing in on challenges and positive changes in individual dietary components.
VIII. References


Retrieved from


Gunther, A. L., Liese, A. D., Bell, R. A., Dabeles, D., Lawrence, J. M., Rodriguez, B. L., ...


Karanja, N. M., Obarzanek, E., Lin, P., McCullough, M. L., Phillips, K. M., Swain, J. F., ...


Retrieved from National Center for Biotechnology Information website: National Heart, Lung, and Blood Institute (US); 2004 Aug. Report No.: 04-5230


Panel of Dietary Intakes for Electrolytes and Water, Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board, Institute of


Fourth National Health and Nutrition Examination Surveys: Could we all be right?.


