UNIVERSITY OF CINCINNATI

Date: 27-Jul-2010

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hereby submit this original work as part of the requirements for the degree of:

Master of Science

in Nutrition

It is entitled:


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Sarah Couch, PhD

Graciela Falciglia, PhD
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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 in the Department of Nutritional Science of the College of Allied Health Sciences

By Ashley Meuser July 27, 2010

B.S., The Ohio State University, 2008

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

Purpose. This study is a mediation analysis of three Social Cognitive Theory (SCT) constructs – knowledge, self-efficacy, and self-regulation to determine their influence on changes in consumption of fruits, vegetables, low-fat dairy products, and high fat/high sodium foods (DASH-4-Teens Diet) in adolescents with hypertension. Methods. Fifty-seven participants with prehypertension or stage 1 hypertension were stratified by gender and race (Caucasian or African American) and randomized to either usual care (n=28), or the DASH-4-Teens (n=29) nutrition intervention. Participants in the usual care group received counseling on established nutrition guidelines from the National High Blood Pressure Education Program to lower their blood pressure. Participants in the DASH-4-Teens group were encouraged to follow the DASH diet, and had 1 individualized counseling session with a Registered Dietitian, 8 weekly and 2 biweekly telephone contacts, and 4 biweekly mailings on behavioral strategies that complement the SCT to lower blood pressure. Diet, knowledge, self-efficacy, and self-regulation were measured at baseline and post-intervention in both groups. Results. The intervention was successful in significantly increasing knowledge ($P < 0.01$), self-efficacy ($P < 0.01$), and self-regulation ($P < 0.01$). Self-efficacy was the predominant mediator in changes in fruit intake ($P < 0.05$). Self-regulation was the predominant mediator in changes in low-fat dairy intake ($P < 0.05$). None of the psychosocial factors in this study were able to significantly explain the increase in vegetable intake or the decrease in DASH-unfriendly foods. Conclusion. A nutrition intervention based on the DASH diet and SCT has the ability to mediate changes in self-efficacy and self-regulation which in turn mediate changes in fruit and low-fat dairy, respectively.
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INTRODUCTION

Recent surveys and studies have shown that adolescents consume excess amounts of fat, sugar, and salt, and inadequate amounts of fruits, vegetables, whole grains, calcium-containing foods, and iron (1, 2, 3, 4). Inadequate physical activity is also a characteristic of adolescents. Energy imbalances are linked to risk and development of chronic diseases, such as obesity, cardiovascular disease, type 2 diabetes, and some cancers (2, 3, 4). Fruit and vegetable intake during childhood can continue into adolescence, and tend to be maintained in adulthood. Thus, using nutritional interventions to alter unhealthy dietary behaviors during adolescence can affect children later in life (3). The aim of the present study is to evaluate the effectiveness of a clinically-based intervention in mediating changes in three Social Cognitive Theory (SCT) constructs. Additionally, this study will evaluate whether the 3 SCT constructs mediate changes in consumption of fruits, vegetables, low-fat dairy products, and high fat/high sodium foods (DASH-4-Teens diet) in adolescents with hypertension.

Fifty-seven participants with prehypertension or stage 1 hypertension were stratified by gender and race (Caucasian or African American) and randomized to either usual care (n=28), or the DASH-4-Teens (n=29) nutrition intervention. DASH participants took part in activities based on the SCT. Mediation analyses of change in SCT constructs (self-efficacy, self-regulation, and knowledge) on change in dietary intake (fruits, vegetables, low-fat diary, and DASH-unfriendly foods) were performed. Use of mediation analysis identifies which mediators effect change in intervention outcomes (e.g. diet). This information can be used to strengthen intervention activities related to the most potent mediators (5).

The DASH intervention was successful in significantly increasing knowledge ($P < 0.01$), self-efficacy ($P < 0.01$), and self-regulation ($P < 0.01$) compared to usual care. Self-efficacy was
the predominant mediator of change in fruit intake ($P < 0.05$). Self-regulation was the predominant mediator of change in low-fat dairy intake ($P < 0.05$). No psychosocial factor was able to significantly explain the increase in vegetable intake or the decrease in DASH-unfriendly food intake.

All 3 SCT constructs increased throughout the intervention and likely had some effect on improving dietary habits. This clinical intervention shows promise of being an intervention that can mediate changes in knowledge, self-efficacy, and self-regulation, which in turn influence changes in consumption of fruits, vegetables, low-fat dairy products, and high fat/high sodium foods (DASH-4-Teens Diet) in adolescents with hypertension.
REVIEW OF LITERATURE

Hypertension in youth is associated with early target organ damage, but can be controlled through dietary modifications. The focus of this literature review is to examine effective nutritional interventions targeted towards improving the diet of adolescents and reducing chronic disease risk. This review will provide (1) the rationale for the use of education theory in the development of nutrition interventions, (2) empirical evidence that changes in diet can be mediated by SCT constructs, (3) rationale for the use of the SCT in nutrition interventions designed for adolescents, and (4) evidence that increasing fruit and vegetable consumption can mediate positive changes in blood pressure. Additionally, gaps in the current literature regarding nutritional interventions for managing pediatric blood pressure adolescents will be elucidated.

I. Rationale for the Use of Theory

Examining the meaning of theory helps to understand why theory-based interventions are most successful when compared to those that are not theory-based (6). The role of theory in designing intervention trials is to simplify the complexity of behavior and provide a focus for interventions (4). Behavioral theories are important tools in interventions aiming to change participant’s intention to engage in a health behavior, and should be involved in all stages of the intervention process, from investigation to evaluation (7, 4). Theory can help identify the beliefs that need to be targeted in order to change the health behavior, as well as significant components of the health behavior (7, 4). Theory tells us how the many determinants of our food choices or mediators of food- and nutrition-related behavior change are related to each other and to the behavior. Theory is used as a guide in research, and specifically its purpose is to describe the nature and strength of the relationships of potential mediators to the behavior change or action
(6). The application of theories to the development and implementation of dietary behavioral interventions enhance their effectiveness; through effective intervention design, effective use of limited resources, and effective assessment (8, 4).

In general, interventions that use appropriate theory and evidence to guide activities are more likely to be successful than those that do not use theory (9, 10, 11, 12). Research has shown that theory-based interventions that are guided by relevant behavioral theories are more likely to significantly impact dietary behaviors in youth (2). A review of 43 nutrition intervention trials directed at the general school-aged population (11-18 years) concluded that all studies that were theory-based, resulted in significant behavior changes compared to those that were not theory-based (3).

Michie et al. (13) proposed that theories used in interventions are effective if they are protocol-based and protocol adherence is assessed. This is done through a five-step pathway (Figure 1). Theory is determined in the first step, and the target of behavior change is specified in the second step. The third step is delivering intervention protocol as planned, the fourth step is the response of the individual, indicating if the intervention has been understood, processed, and acted upon, and the final step is the targeted behavioral outcome.

**Figure 1. Mediating Links Between Theories of Behavior and Behavioral Outcome**
II. Changes in Diet Mediated by Social Cognitive Theory Constructs

Cognitive-behavioral variables, such as self-efficacy and self-regulation, are important determinant of decisions regarding dietary intake (14). These two variables are important constructs within the SCT. The SCT states that behavior, including dietary behavior, is the result of environmental and personal factors (15). The SCT specifies a core set of determinants, the mechanism through which they work, and the optimal ways of translating this knowledge into effective health practices (16). Core determinants of the SCT include: knowledge of health risk and benefits of different health practices; self-efficacy that one has the confidence to control one’s own health habits; and self-regulation that an individual has the ability to direct and control his/her behavior (16, 6).

According to the SCT, if people lack the knowledge about their lifestyle habits that affect their health, they have little reason to change their habits. Therefore, knowledge of health risk creates the precondition for change (16). Interventions aimed at changing dietary behavior in youth should target self-efficacy, a key construct of the SCT (8). Self-efficacy is a focal determinant within the SCT because it plays a central role in personal change, and is the foundation of human motivation and action (16). Self-efficacy has the ability to influence personal behaviors or choices, promote the adoption of new behaviors, and therefore is often a powerful predictor of nutrition-related behavior change (14). The greater a subject’s self-efficacy, the greater the likelihood that the behavior will be repeated (17). For example, the higher an individual’s self-efficacy toward eating fruits, the more likely the individual is to eat 5 servings of fruits per day and continue this practice throughout their lifetime. Self-efficacy has
the ability to affect health behavior both directly and indirectly through the development and use of self-regulatory behaviors (16, 18).

Self-regulation is an important construct of the SCT and similar to self-efficacy it has been found to be a strong predictor of dietary behavior (14). Self-regulation involves many different components including the realization that there is a need to change a behavior (i.e. an adolescent notices they are only eating 2 servings of fruits and vegetables per day). This realization helps identify determinants of one’s behavior, and provides the information needed for setting realistic goals. Following this self-awareness, behavioral change or action goals are set and nutrition skills needed to achieve these goals are learned. Progress towards achieving the goals is monitored, and rewards can be obtained when the goals are met (6). Dietary change requires active self-regulation of food intake, and is enhanced by combining goal setting and self-monitoring (19). It is believed that subjects will only be successful in self-regulation if self-efficacy is enhanced (17). For example, an adolescent will only be able to consume 5 servings of fruits per day if they set this goal, believe they can achieve this goal, and have self control over their eating habits. The 3 SCT constructs of knowledge, self-efficacy, and self-regulation are all needed in facilitating positive changes in dietary behavior (18).

A meta-analysis of 77 studies (cross-sectional, prospective, and experimental) conducted between 1990 and May 2009 in participants less than 18 years used at least one psychosocial variable as an independent variable when measuring dietary intake. The association between self-regulation, self-efficacy, or knowledge and fat intake could not be determined because of the low number of studies that investigated the association between these constructs and fat intake. When examining fruit, fruit juice, and/or vegetable (FJV) consumption, six out of nine studies
found knowledge to be positively associated with FJV consumption; however self-efficacy did not show consistent associations with FJV consumption (2). Cerin et al. (8) concluded that attempts to increase knowledge about the daily recommended amounts of fruits and vegetables were consistently successful in increasing knowledge and intake of these food groups (8).

Baranowski et al. (20) developed a curriculum-only intervention, Squires Quest! that was designed to increase fruit and juice and vegetable intake (FJV) among adolescents. Numerous SCT constructs were used, including self-regulation, self-efficacy, goal setting, reinforcement, and behavioral capacity. Post-intervention, children in the treatment schools consumed approximately one more serving of FJV per day than children in control schools. Constructs were not measured throughout the intervention (i.e. whether or not the intervention was able to increase self-regulation while increasing FJV intake). Measurements were not taken to determine which construct was successful in increasing consumption (i.e. if self-regulation had a bigger impact on increasing FJV when compared to goal setting), but this trial provides evidence that a curriculum based on the constructs of the SCT constructs can promote an increase in FJV consumption (20).

Baranowski et al. (21) developed a nutritional intervention called 5 a Day Achievement Badge to increase FJV intake in African-American adolescent boy scouts. The majority of SCT constructs were addressed within this intervention: self-efficacy, self-regulation, behavioral capacity, expectations, observational learning, and reinforcement. Post-intervention, FJV consumption increased as well as preference for FJV. Some limitations of this study include lack of measurements to determine which construct(s) mediated change in consumption. This
nutritional intervention does provide evidence that increasing FJV consumption can be achieved by addressing the majority of SCT constructs (21).

Baranowski et al. (22) created Gimme 5 Fruit, Juice, and Vegetables for Fun and Health (Gimme 5). This nutritional intervention focused on several SCT constructs: knowledge, self-regulation, self-efficacy, behavioral capacity, expectations, and observational learning. Post-intervention, FJV intake and knowledge significantly increased in the treatment school when compared to the control school (22). Similar to the previous studies, measurements were not taken to determine which construct(s) contributed significantly to increased consumption.

The Cookshop, developed by Liquori et al. (23), aimed at increasing consumption of whole grains and vegetables in children age 3-12. SCT constructs addressed were knowledge, self-efficacy, behavioral capacity, expectations, and reinforcement. Participants in the treatment school increased grain and vegetable intake compared to participants in control school. At completion of the intervention knowledge increased and self-efficacy increased in older students in the treatment school (23). This nutritional intervention did not use mediation analyses and was therefore unable to determine whether knowledge or self-efficacy mediated change in grain or vegetable intake.

Perry et al. (24) developed 5-a-Day Power Plus aimed at increasing fruit and vegetable consumption in 10 year olds. SCT constructs examined were knowledge, self-efficacy, behavioral capacity, observational learning, and reinforcement. The students in the treatment school significantly increased fruit and vegetable consumption at lunchtime, and increased knowledge and self-efficacy when compared to control schools (24). Mediation analyses were
not performed to determine which construct(s) contributed significantly to increased consumption.

Reynolds et al. (25) developed the High 5 project aimed at increasing fruit and vegetable intake in 10 year old students. SCT constructs that were addressed were knowledge, self-efficacy, self-regulation, behavioral capacity, expectations, observational learning, and reinforcement. The intervention was able to significantly increase fruit and vegetable intake by 1.68 servings per day in children in the intervention group at the first follow-up, and 1 serving at the second follow-up compared to the control group. Self-efficacy and knowledge were both significantly increased in the intervention group compared to the control group (25). Mediation analyses were not performed to determine which construct(s) contributed significantly to increased consumption.

These numerous interventions provide evidence that addressing SCT constructs in nutritional interventions has the ability to increase FJV or fruit and vegetable consumption. Numerous theories were able to show positive effects when addressing the majority of SCT constructs, but SCT is an extremely broad theory and it may not be feasible to address all constructs within the theory (4, 21, 22, 23, 25). A major limitation of these studies is lack of measurement of change in constructs and mediating analyses to determine which construct(s) were most successful at producing change in the outcomes.

III. Rationale for the Use of the Social Cognitive Theory in Adolescents

The SCT conceptualizes multiple influences on behavior, with a primary focus on cognitive and social factors, and provides a reciprocal model in which behavior, personal factors, and environmental influences interact continuously (26, 3). Various types of behavioral, personal,
and environmental variables are also influential on the food consumption behavior of adolescents (27). The most dominant theory used in the development of programs for adolescents has been the SCT, and it has been shown to be particularly effective at achieving sought after results (3).

Many reasons for the success of the SCT have been described. The ability of interventions based on the SCT to improve diet quality in adolescents may be due to rewards and orientation toward the future (i.e. future results of their behaviors), which is a cognitive process. For example, adolescents may realize that healthy eating at their age will prevent the development of nutrition-related diseases and help maintain a healthy weight throughout their life. Cognitive representation of future states may motivate adolescents to engage in preventive health behaviors, like healthy eating and physical activity (14). Targeting cognitive processes has the ability to motivate adolescents to engage in healthy eating. Another reason for the success of the SCT when used for designing interventions for adolescent diet behavior change, particularly fruit and vegetable intake, is that consumption is dependent on personal characteristics (such as preference), and on external factors (such as availability). The SCT targets both individual and environmental level influences on behavior, and is therefore fitting for fruit and vegetable interventions geared for adolescents (4).

Many interventions based on the SCT and focusing on promotion of healthy diet and physical activity changes in children have proven efficacious. After 3 years, the Child and Adolescent Trial on Cardiovascular Health (CATCH) demonstrated that the SCT intervention had a positive effect on knowledge, intentions, self-efficacy, dietary behavior, and perceived social reinforcement for healthy food choices (28). Adolescents participating in a SCT-based intervention, Eat Well and Keep Moving, were able to increase fruit and vegetable consumption gradually over 2 years (29). In a meta-analysis of 57 school-based interventions to promote
change in fruit and vegetable intake Thomas (30) concluded that only 4 out of the 57 were successful. Of the successful interventions, three of them were based on the SCT. A common limitation among the unsuccessful interventions was lack of stated theoretical basis, or lack of theoretical explanation of results (30). Empirical evidence supported the efficacy of theory-driven interventions, so theoretical basis should be used in intervention design and implementation. Additionally clinical trials based on behavior change theories should focus on measuring changes in the constructs to determine which construct(s) mediate behavior changes (31). The previously mentioned successful SCT interventions provide evidence that they can be effective in altering dietary habits in children and adolescents (32).

IV. Changes in Fruit and Vegetable Consumption Mediating Changes in Blood Pressure

Primary prevention of elevated blood pressure (BP) includes lifestyle modifications. These include management of body weight, an increase in physical activity, and the adoption of a diet low in sodium, but rich in fresh fruits and vegetables, fiber, and low-fat dairy foods (33). Some evidence suggests that diets high in specific nutrients such as potassium, calcium, and magnesium are inversely related to BP levels (34). Although studies on the relationship between fruits, vegetables, and low-fat dairy and BP are few, available evidence supports a behavioral effect of this dietary pattern on lowering BP levels over single nutrient effects (33). The Dietary Approaches to Stop Hypertension (DASH) clinical trial was studied in adults with stage I hypertension, and resulted in significantly reduced BP levels. The DASH diet was originally rich in potassium, calcium, magnesium, fiber, and protein, and lower in total fat, saturated fat, and cholesterol. This was then translated into food groups to make it easier to follow and included a diet high in fruits and vegetables and low-fat dairy products (35). Due to the success
of the DASH diet in adults with hypertension, the relationship was studied among adolescents (34, 36).

Based on cross-sectional data, diets high in dairy (nonfat or reduced fat) and fruits and vegetables were able to lower blood pressure in adolescents (36, 37). Children participating in the Framingham Children’s Study (37) provided evidence that consuming a combination of high dairy and high fruit and vegetable provided the greatest blood pressure benefit. Children with high intakes of fruits and vegetables alone (not in conjunction with high dairy intake) or dairy alone (not in conjunction with high fruit and vegetable intake) had intermediate levels of adolescent systolic blood pressure. Those with lower intakes of fruits and vegetables and lower dairy intakes had the highest blood pressures (37). In one cross-sectional study, Falkner et al. (34) concluded that diets high in fruits, vegetables, and low-fat dairy products (rich in potassium, calcium, magnesium, and vitamins) may contribute to primary prevention of hypertension and lower BP levels among adolescents at risk for hypertension (BP levels higher than the 90th percentile) if instituted at a young age (34).

V. Gaps in the Literature

Based on the examined literature, it is evident that more dietary interventions using mediation analysis are needed. These interventions have the ability to determine which targeted SCT construct mediated change in consumption and reduce BP levels. Numerous interventions examining mediators of dietary behavior change in youth fail to assess whether changes in the mediators preceded changes in dietary intake, which is an important criterion of mediation. It is possible that changes in dietary behavior would cause changes in the mediator. For example, changes in self-efficacy may lead to changes in dietary behavior and vice versa (8). There are
many constructs, mediating variables, and other factors involved in both the SCT and food consumption. The SCT is a comprehensive model, and there are a number of unspecified processes that could be accounting for the effects seen if mediation analysis is not performed (32).

Efforts to influence the dietary patterns of youth can take place in schools, the community, or clinical settings. There is a lack of clinical-based interventions focusing on the treatment of hypertension in adolescents, an important age to target in order to reduce hypertension-related complications seen later in life. The lack of clinically-based interventions is important to note because adolescents are diagnosed with hypertension in a clinical setting. Therefore a larger number of adolescents diagnosed with hypertension can be targeted for treatment and further prevention of later stages of hypertension.

Educational efforts alone, without implementation of theory are usually unsuccessful at positively changing youths’ diets. According to Bandura (16), these interventions provide factual information about health, but usually do little to equip children with the skills and efficacy beliefs that enable them to manage the emotional and social pressures to adopt detrimental health habits (16).

**PURPOSE**

To evaluate the effectiveness of a clinically-based intervention in mediating changes in three SCT constructs. Additionally, this study will evaluate whether the 3 SCT constructs in turn will mediate changes in consumption of fruits, vegetables, low-fat dairy products, and high fat/high sodium foods (DASH-4-Teens diet) in adolescents with hypertension.
HYPOTHESIS

Two hypotheses are examined; whether (1) the intervention will positively change the 3 SCT constructs of knowledge, self-efficacy, and self-regulation, and (2) changes in the 3 SCT constructs mediate positive changes in fruit, vegetable, low-fat dairy, and high fat/high sodium consumption from baseline to post-intervention in adolescents who participated in the DASH-4-Teens intervention.

METHODS

Recruitment

Adolescents age 11-18 with a clinical diagnosis of prehypertension or hypertension were recruited from the Cincinnati Children’s Hypertension Center (CCHC) at the Cincinnati Children’s Hospital Medical Center (CCHMC) during their initial visit to the CCHC. Recruitment was through a CCHC cardiologist, registered dietitian (RD), or waiting room flyers. The CCHC is a referral program for the diagnosis and treatment of children with hypertension. Patients are admitted to the CCHC after being referred by their primary health provider after a systolic or diastolic blood pressure reading is above the 90th percentile for their age and height. Three persistent systolic blood pressure (SBP) and/or diastolic blood pressure (DBP) readings between the 90th and 95th percentile for age, gender, and height are used for diagnosis of prehypertension. SBP and/or DBP readings $\geq$95th and <99th percentile for age, gender, and height + 5mmHg are used for diagnosis of stage 1 hypertension. After diagnosis of prehypertension or hypertension, all children underwent a complete medical history and physical examination to help target the cause of hypertension, general screenings (i.e. weight and serum
louislipids) to determine cardiovascular risk factors, and family history of cardiovascular disease in parents, grandparents, aunts, and uncles.

Adolescents were excluded if they had a secondary cause of hypertension, such as renal disease or diabetes, if they were taking medication to treat high blood pressure, and/or if they were unwilling to stop use of vitamins, minerals, or antacids containing magnesium or calcium. Exclusion criteria are explained in further detail elsewhere (36). Parental consent and adolescent assent were obtained prior to beginning the study. The study was approved by the Institutional Review Board at CCHMC and University of Cincinnati.

Subjects

Seventy individuals agreed to study participation. Sample size estimation was based on a repeated measures design. This included 3 separate measurements per subject, made at equally spaced intervals at baseline, 3 months, and 6 months, a correlation between intrasubject measurements equal to 0.5, a posited difference in SBP change equal to 2 mm Hg over a 1-year period, and a standard deviation of SBP values equal to 1.5 mm Hg. A sample size of 27 participants per condition was estimated to provide 80% power to detect the posited difference between DASH and usual care group, at the 5% level.

Study Design

Once agreeing to participate and signing consent forms, participants were informed that a RD would call them on two separate occasions within the following two weeks to obtain a 24-hour recall. At the initial visit, all participants met with a registered dietitian and were trained to use the portion size model to estimate portion sizes of a variety of foods and beverages to help
complete the 24-hour recalls. Blood pressure was taken twice on their right arm and in the seated position by trained personnel using a standard sphygmomanometer. Medical history and physical examination was completed, and biochemical data was obtained. Subjects self-reported their birth date, gender, and race. Participants also completed a knowledge, self-efficacy, and self-regulation questionnaire.

Two weeks after the initial visit, participants returned to the CHCC and had their blood pressure taken, and height and weight recorded. Diagnosis of hypertension or prehypertension was determined after 3 measurements were averaged: the 2 in-clinic blood pressure measurements, and the measurement used for referral to the CHCC. Blood pressure readings, medical, physical, and biochemical data were examined by a cardiologist to ensure no secondary cause of hypertension. If diagnosed with hypertension or prehypertension with no secondary cause, the participants were then randomized to usual care or DASH-4-Tens group. Fifty-seven participants (after exclusion) were stratified by gender and race (Caucasian or African American) and randomized to either usual care (n=28), or DASH-4-Tens (n=29) nutrition intervention. Randomization was done by researchers that were blinded to assessment and recruitment results. The intervention was 12 weeks long.

**DASH Intervention**

After randomization, DASH-4-Tens individuals met with a RD and counseled on the DASH diet plan, and a post-intervention assessment was scheduled for 3 months after the counseling session. The diet plan used in this DASH-4-Tens study is presented in Table 1 and is slightly modified from the adult DASH diet and allows adolescents to meet their nutritional...
needs and is explained in further detail elsewhere (38, 36). The current DRI’s were met for males and females 11-18 years of age for energy, fiber, macronutrients, and micronutrients.

Table 1. DASH-4-Teens Eating Pattern and Nutritional Analysis

<table>
<thead>
<tr>
<th>Serving Recommendation/Day</th>
<th>Female Age</th>
<th>Male Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dash-4-Teens Diet Plan</td>
<td>11-13</td>
<td>14-18</td>
</tr>
<tr>
<td>Grains</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Vegetables</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Fruits</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Dairy</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Meat</td>
<td>6 (oz.)</td>
<td>6 (oz.)</td>
</tr>
<tr>
<td>Nuts &amp; Seeds</td>
<td>4 per week</td>
<td>4 per week</td>
</tr>
<tr>
<td>Fats &amp; Oils</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Sweets</td>
<td>5 per week</td>
<td>5 per week</td>
</tr>
<tr>
<td><strong>Nutritional Analysis (% DRI)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calories</td>
<td>2097 (101%)</td>
<td>2373 (100%)</td>
</tr>
<tr>
<td>Protein (% kcal)</td>
<td>18.4%</td>
<td>17.3%</td>
</tr>
<tr>
<td>Carbohydrate (% kcal)</td>
<td>51.2%</td>
<td>52.3%</td>
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<tr>
<td>Fat (% kcal)</td>
<td>30.0%</td>
<td>30.0%</td>
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<td>Sodium (mg)</td>
<td>2203 (92%)</td>
<td>2235 (93%)</td>
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<tr>
<td>Potassium (mg)</td>
<td>3190 (160%)</td>
<td>3750 (188%)</td>
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<tr>
<td>Calcium (mg)</td>
<td>1481 (114%)</td>
<td>1357 (104%)</td>
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<td>Magnesium (mg)</td>
<td>366 (153%)</td>
<td>445 (124%)</td>
</tr>
<tr>
<td>Fiber (g)</td>
<td>25 (97%)</td>
<td>27 (106%)</td>
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</tbody>
</table>

* Menus were planned to meet or exceed (≤150%) of the Dietary Reference Intakes for males and females 11-18 years for energy, macronutrients, fiber, micronutrients, the American Heart Association’s recommendations for fat, saturated fat and cholesterol, and food serving recommendations were adapted from Box 7 reference 39, and reference 40.

The components included in the DASH intervention were designed to help participants conform to the DASH-4-Teens eating plan and were influenced by the SCT. The intervention included one individualized counseling session, 4 biweekly mailings (mailed during weeks 2, 4,
6, and 8 of the intervention), and 8 weekly and 2 biweekly telephone contacts. The format of the intervention was modeled after a nutrition intervention for overweight adolescents developed by Saelens et al., which found that adolescents experience a greater amount of weight loss when engaged in behaviorally oriented telephone calls and mailings. This was shown to be cost effective and an easy way to distribute information to adolescents (41).

**Individualized Counseling Session:** Participants spent 45-60 minutes with their parents and a dietitian during their individualized counseling sessions. During this session, they discussed their current eating habits and an action plan for meeting the DASH-4-Teens dietary goals (increasing fruits and vegetables, dairy products, and decreasing high fat/high sodium food choices). The action plan discussed included short range goals, strategies to achieve goals, and how to overcome any obstacles. A 10-module illustrated manual on the DASH-4-Teens diet plan was provided to participants at the counseling session. It explained the benefits of the DASH diet, DASH food serving recommendations, extensive food list, tips for incorporating DASH foods into their diet, food monitoring protocol and instructions, guidelines for goal setting, action planning, self-rewarding, social support, and handling high risk situations.

**Mailings:** The mailings were comprised of 1-page information sheets that contained behavior modification strategies and were sent to the parents of participants for use in helping their child follow the diet plan by creating a home environment supportive of the DASH food plans.

**Telephone Contact:** The telephone component of the intervention began 1 week after the initial counseling session. Participants were contacted each week for 8 weeks, then biweekly for the remaining 4 weeks of the intervention. Each call was approximately 20 minutes long and
addressed food self-monitoring, dietary goal accomplishment, and specific behavior change strategies focusing on specific constructs central to the SCT (Table 2). The goals that were addressed included 1) keeping detailed food records; 2) increasing the intake of fruits and vegetables to meet the DASH recommendations; 3) increasing the intake of low-fat dairy foods; and 4) lowering the intake of high fat/high sodium foods to 2 per day. In order to meet these needs, teens needed to lower foods that were more than 3 grams of fat and 480 mg of sodium per serving, foods that are not included in the DASH diet. Participants kept food diaries and mailed them to the interventionists weekly. One dollar was rewarded to the participant for each DASH food-related goal met, a potential to earn $48.00 if all DASH goals were met for the entire 12 week period. Dr. Brian Saelens, a developmental psychologist at CCHMC, trained all telephone interventionists in the provision of dietary behavioral modification strategies. Interventionists used detailed call scripts, and conversations with study participants were audio taped to ensure compliance with the scripts.

**Post-Intervention:** At the post-intervention visit (at 12 weeks) participants received a routine physical examination, completed knowledge, self-efficacy, and self-regulation questionnaires, and height, weight, and 3 blood pressure readings were obtained. No additional nutrition counseling was provided at this time. At the 6-month follow-up the same measurements were performed and obtained. Participants obtained $20.00 for traveling to the follow-up visits.
Table 2. Theoretical concepts used to develop nutrition intervention and selected concept applications

<table>
<thead>
<tr>
<th>Concept (and Definition)</th>
<th>Selected Concept Application</th>
</tr>
</thead>
</table>
| Knowledge (food- and nutrition-related motivational\(^a\) and instrumental knowledge\(^b\)) | -Participants applied concepts during face-to-face and telephone counseling sessions (i.e. menu planning, modifying recipes, meal and snack preparation, setting goals, and action planning)  
- A manual with activities provided to participants to reinforce concepts discussed in counseling/telephone sessions  
- Key concepts illustrated with diagrams or pictures in manual |
| Self-Efficacy (perceived confidence in performing a specific behavior) | -Curriculum activities allowed families to apply each new concept (i.e. measuring portion sizes, label reading, menu planning, identifying foods by food group) |
| Self-Regulation (personal control) | -Daily monitoring of food intake by teens  
- Weekly goal establishment by teens  
- Weekly non-food reward establishment by teen |

\(^a\) motivational knowledge – knowledge that facilitates motivation to act  
\(^b\) instrumental knowledge – knowledge that is needed to take action

Usual Care

Participants in the usual care group had an initial 45-60 minute counseling session with a CHCC RD. At this time they were provided with a National High Blood Pressure Education Program booklet, *Eat Right to Help Lower Your High Blood Pressure*, written at the 5\(^{th}\) grade level (40). It encourages the reduction of sodium intake to 2400 mg per day, controlling weight by limiting high fat foods (≤30% of calories), reducing portion sizes, incorporating fruits, vegetables, lean meats, and low fat dairy in their diet, and eating the nutrient-dense forms of foods. No specific calories or servings were recommended. The next contact was 2 weeks before (as previously mentioned) completion of the intervention to schedule the follow-up visits.

Post-Intervention: At the post-intervention visit (at 12 weeks) participants received a routine physical examination, completed knowledge, self-efficacy, and self-regulation questionnaires, and height, weight, and 3 blood pressure readings were obtained. No additional
nutrition counseling was provided at this time. At the 6-month follow-up the same measurements were performed and obtained. Participants obtained $20.00 for traveling to the follow-up visits.

Measures

Study measurements were taken in the CCHC at enrollment (baseline), at the end of the 3-month intervention, and at a 3-month follow-up. Measurements were conducted by trained clinic staff blinded to treatment assignment. A copy of the questionnaires completed by participants are in Appendix I.

Knowledge: To measure knowledge, a 15 item questionnaire was designed to assess motivational knowledge (knowledge that facilitates motivation to act) and instrumental knowledge (knowledge that is needed to take action) (26). The motivational knowledge questions (8 items) addressed the relationship between foods, nutrients and the DASH dietary pattern, and blood pressure. The instrumental knowledge questions (7 items) addressed skills needed to adopt new dietary behaviors (i.e. reading labels, grocery shopping, and determining serving sizes of DASH foods). The test was multiple choice and had one true/false question. The possible total score range was 0-15; 0-8 for motivational knowledge, and 0-7 for instrumental knowledge. Five RDs with experience in management of pediatric hypertension reviewed the instruments for content validity, and it was found to have acceptable content validity. Content validity was determined based on a scale for each question. The scale ranged from 1-5, with 5 being high validity. Most questions received a 5, and the lowest score given was a 4.5, proving high content validity.
**Self-Efficacy:** A 10-item questionnaire was developed to assess participant’s level of self-efficacy in performing diet-related skills necessary to modify their diet. Skills assessed were reading food labels, setting and reaching food-related goals, and shopping for healthful foods at the grocery store. This questionnaire was created following a similar questionnaire determining self-efficacy associated with altering fruit and vegetable intake among adolescents by Betts et al. (42), which was validated for internal consistency and test-retest reliability (42). A Likert scale was used with each answer ranging from 1 (strongly disagree) to 5 (strongly agree). The possible total score range was 10-50; 10 corresponded to higher self-efficacy.

**Self-Regulation:** Eleven questions within the “Adolescent Skills Use” questionnaire were assessed to measure the participant’s self-regulation. Skills assessed were daily monitoring of food choices, goal setting, and non-food reward establishment. A 5 point scale was used with 1 corresponding to never and 5 corresponding to very often. The 11 answers were averaged; 5 corresponded to the highest self-regulation an individual could have using our scale.

**Dietary Intake:** Dietary intake was assessed using three 24-hour recalls over a 2-week period (2 weekdays and 1 weekend day), collected by trained personnel blinded to treatment assignment. Adolescents used the information taught using the 2-dimensional portion size model (Nutrition Consulting Enterprises, Framingham, MA) at the initial visit to determine the quantity of food eaten. Using this model has been shown to significantly enhance recall of different food volumes and dimensions (43). Recalls were analyzed for nutrient content, specifically total fat, saturated fat, calcium, potassium, and magnesium, and low-fat dairy and high fat/high sodium intake using the Minnesota Nutrition Data Systems software, version 5.0 (2003). The number of servings of fruits, vegetables, low-fat dairy foods, and high fat/high sodium foods were
calculated. This information was used to evaluate participant attainment of the DASH dietary pattern (8 servings per day of fruits and vegetables, 3 servings per day of low fat dairy foods, and <30% of calories from fat). High fat/high sodium foods (>3 grams of fat; ≥450 mg sodium) are referred to as DASH-unfriendly foods.

**Statistical Analysis**

Four separate analyses were conducted to test hypotheses 1 and 2. Analysis 1 examined descriptive statistics of sample characteristics and drop-outs at baseline. This was necessary in order to determine if those that dropped out of the intervention were similar to those that completed the intervention. Independent sample t-tests and chi-square tests were used to conduct drop-out analyses and compare completers and drop-outs by group (DASH or control). For completers, the residualized change score was calculated for intake of fruit, vegetable, low-fat dairy, and DASH unfriendly foods (analysis 2). The residualized change score, a measure of change of intake between baseline and visit 2, was calculated by regressing the intake measures at visit 2 onto the intake measures at baseline. The residualized change score is the amount of increase or decrease in intake between the baseline and visit 2 values and is independent of baseline intake. The intake values at visit 2 were regressed onto the intake values at baseline to compute the residual intake change score. Psychosocial determinant values at visit 2 were regressed onto psychosocial determinant values at baseline to compute the residual psychosocial determinant change score. This accounts for the possibility that those with low scores at baseline will have more room for change compared to those with high baseline scores (44). Students t-test were run to determine whether there were significant difference between residual change score of DASH vs. usual care participants. Analysis 3 involved using Pearson correlations to
assess the relationship among potential mediators. Analysis 4 assessed the mediating effect of change in psychosocial factors on change in dietary variables. The effects of the intervention on changes in the psychosocial determinants were estimated by regressing changes in each psychosocial determinant onto the intervention. The residual change score of each psychosocial factor was the outcome variable and the intervention was the independent variable. The mediation effect of change in psychosocial factors on change in fruit, vegetable, low-fat dairy, and DASH-unfriendly intake was estimated by regressing changes in each dietary outcome onto the intervention and changes in each of the psychosocial determinants.

RESULTS

Individuals in this intervention completed a baseline, post-intervention (at 3 months), and follow-up assessment (at 6 months). The results presented here consider baseline and post-intervention values only, which are represented as visit 1 and visit 2, respectively. Twenty-four participants completed visit 1 and 2 in the DASH group, and 22 participants completed visit 1 and 2 in the usual care group.

Results from analysis 1, descriptive statistics of sample characteristics and drop-outs at baseline, are presented in Table 3. Taking into account all participants that were randomly assigned to either DASH or the control group, the majority of participants were white (67%), male (63%), and had a mean age of 14.66. At baseline, there were no significant differences between participants that completed visit 1 and visit 2 (completers) in the DASH group compared to those in the control group for age, race, gender, BMI z-score, diastolic blood pressure, fruit, vegetable, low-fat dairy, or DASH-unfriendly food intake, knowledge, self-efficacy, or self-regulation score. Differences between DASH and control completers were
observed for baseline systolic blood pressure. Participants in the DASH group had significantly higher systolic blood pressure at baseline, compared to the control group ($P < 0.01$). There were no significant differences between DASH completers, and DASH drop-outs in any of the baseline characteristics. At baseline, there were no significant differences between control completers and control drop-outs for age, gender, BMI z-score, diastolic blood pressure, vegetable intake, DASH-unfriendly food intake, or knowledge. There were significantly more white control completers vs. drop-outs ($P < 0.05$). Additionally, at baseline control drop-outs had significantly higher systolic blood pressure ($P < 0.05$) and self-efficacy ($P < 0.01$) than control completers. Completers had significantly higher baseline fruit intake ($P < 0.01$) and self-regulation ($P < 0.01$) than control drop-outs.
Table 3. Mean Values (SD) of Subject Baseline Characteristics

<table>
<thead>
<tr>
<th>Subject Baseline Characteristics</th>
<th>DASH Completers a</th>
<th>DASH Drop-outs b</th>
<th>Control Completers c</th>
<th>Control Drop-outs d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>24</td>
<td>5</td>
<td>22</td>
<td>6</td>
</tr>
<tr>
<td>Age</td>
<td>13.96 (2.05)</td>
<td>15.80 (1.79)</td>
<td>14.36 (2.22)</td>
<td>14.50 (1.05)</td>
</tr>
<tr>
<td>Race, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>17 (71)</td>
<td>3 (60)</td>
<td>12 (55)*</td>
<td>6 (100)*</td>
</tr>
<tr>
<td>African-American</td>
<td>7 (29)</td>
<td>2 (40)</td>
<td>10 (45)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Gender, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>16 (67)</td>
<td>2 (40)</td>
<td>14 (64)</td>
<td>4 (67)</td>
</tr>
<tr>
<td>Female</td>
<td>8 (33)</td>
<td>3 (60)</td>
<td>8 (36)</td>
<td>2 (33)</td>
</tr>
<tr>
<td>BMI Z-Score</td>
<td>1.82 (0.64)</td>
<td>1.43 (0.64)</td>
<td>1.67 (0.82)</td>
<td>2.10 (0.52)</td>
</tr>
<tr>
<td>SBP</td>
<td>132.3 (8.99)***</td>
<td>126.4 (8.91)</td>
<td>124.7 (6.50)*</td>
<td>131.3 (5.43)*</td>
</tr>
<tr>
<td>DBP</td>
<td>79.46 (6.76)</td>
<td>79.00 (3.87)</td>
<td>82.32 (7.23)</td>
<td>80.00 (5.22)</td>
</tr>
<tr>
<td>Fruit Intake</td>
<td>0.98 (1.19)</td>
<td>0.71 (0.80)</td>
<td>0.68 (0.77)**</td>
<td>0.07 (0.10)**</td>
</tr>
<tr>
<td>Vegetable Intake</td>
<td>1.64 (1.00)</td>
<td>1.63 (1.11)</td>
<td>1.17 (0.95)</td>
<td>2.04 (1.29)</td>
</tr>
<tr>
<td>LF Dairy Intake</td>
<td>1.29 (1.34)</td>
<td>0.79 (0.53)</td>
<td>1.49 (2.07)**</td>
<td>0.48 (0.39)**</td>
</tr>
<tr>
<td>UF Intake</td>
<td>5.87 (2.17)</td>
<td>7.13 (4.15)</td>
<td>5.54 (2.95)</td>
<td>4.61 (2.40)</td>
</tr>
<tr>
<td>Knowledge</td>
<td>10.21 (2.46)</td>
<td>10.00 (1.42)</td>
<td>9.67 (2.61)</td>
<td>9.17 (3.25)</td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td>21.08 (4.61)</td>
<td>24.60 (4.72)</td>
<td>23.09 (5.97)*</td>
<td>20.17 (0.98)*</td>
</tr>
<tr>
<td>Self-Regulation</td>
<td>1.65 (0.71)</td>
<td>1.48 (0.57)</td>
<td>1.61 (0.85)*</td>
<td>1.09 (0.14)*</td>
</tr>
</tbody>
</table>

DASH, Dietary Approaches to Stop Hypertension; BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; LF Dairy, low-fat dairy; UF intake, DASH-unfriendly food intake.

a Participants in the DASH intervention that completed baseline visit (visit 1) and post-intervention visit (visit 2)
b Participants in the DASH intervention that only completed baseline visit (visit 1)
c Participants in the Control group that completed baseline visit (visit 1) and post-intervention visit (visit 2)
d Participants in the Control group that only completed baseline visit (visit 1)
e Knowledge – based on a scale of 0-15, where, higher score indicates greater knowledge
f Self-efficacy – based on responses to Likert Scale of 1-5 (total range of 10-50) where lower score = greater self-efficacy
g Self-regulation – based on responses to a Likert Scale of 1-5 (total range of 1-5) where higher score = greater self-regulation
* P < 0.05, Completers significantly different from drop-outs
** P < 0.01, Completers significantly different from drop-outs
*** P < 0.01, DASH completers significantly different from control completers

The residualized change score was calculated. It was subsequently used to determine the correlation among potential mediators and the mediating effect of psychosocial variables on the
outcome of the intervention (Tables 4, 5 & 6). The residualized change score is the amount of increase or decrease in dietary and psychosocial variables between visit 1 and visit 2. It takes into account change from baseline to visit 2, and can therefore present correlation between the intervention dietary and psychosocial variables independent of baseline values. The correlation among residual change scores is more accurate because it does not take into account extreme values, but rather the change in values, and accounts for the possibility that participants with high DASH-unfriendly intake or low fruit, vegetable, and low-fat dairy intake at baseline will have more room for change compared to those with opposite intake levels (low versus high). Residualized change scores for dietary intake and psychosocial variables were used in analysis 3 to assess the correlation among potential mediators (Table 4).

The intervention showed that fruit intake was significantly positively correlated to knowledge ($P < 0.05$) and self-regulation ($P < 0.05$), and negatively correlated to self-efficacy ($P < 0.05$). It should be noted that lower self-efficacy scores indicate a higher level of self-efficacy due to reverse scoring. Thus, as knowledge, self-efficacy, and self-regulation increase, fruit intake increases. The correlations were strongest for fruit intake, self-regulation, and knowledge. Self-efficacy was moderately correlated with fruit intake. There were no significant correlations with vegetable intake and any psychosocial variable. Self-efficacy had a moderate negative correlation with low-fat dairy intake ($P < 0.05$) indicating higher self-efficacy was associated with higher low-fat dairy intake. Self-regulation had a moderate positive correlation with low-fat dairy intake ($P < 0.05$). DASH-unfriendly intake had a moderate positive correlation with self-efficacy ($P < 0.05$), indicating that when participants had more confidence that they could change their dietary behavior, they were more likely to lower their intake of DASH-unfriendly foods.
Table 4. Correlation among Potential Mediators and Dietary Outcomes (Pearson Correlation Coefficients/p-value)

<table>
<thead>
<tr>
<th></th>
<th>Dietary Variables</th>
<th>Psychosocial Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fruit</td>
<td>Vegetable</td>
</tr>
<tr>
<td><strong>Dietary Variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Vegetable</td>
<td>0.22</td>
<td>1.00</td>
</tr>
<tr>
<td>(0.15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LF Dairy</td>
<td>0.24</td>
<td>0.33</td>
</tr>
<tr>
<td>(0.11)</td>
<td>(0.02)</td>
<td></td>
</tr>
<tr>
<td>Unfriendly</td>
<td>-0.22</td>
<td>-0.08</td>
</tr>
<tr>
<td>(0.15)</td>
<td>(0.60)</td>
<td>(0.05)</td>
</tr>
<tr>
<td><strong>Psychosocial Variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge</td>
<td>0.48</td>
<td>0.14</td>
</tr>
<tr>
<td>(0.0007)**</td>
<td>(0.36)</td>
<td>(0.35)</td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td>-0.41</td>
<td>-0.11</td>
</tr>
<tr>
<td>(0.0049)**</td>
<td>(0.45)</td>
<td>(0.01)*</td>
</tr>
<tr>
<td>Self-Regulation</td>
<td>0.61</td>
<td>0.09</td>
</tr>
<tr>
<td>(&lt;0.0001)**</td>
<td>(0.56)</td>
<td>(0.02)*</td>
</tr>
</tbody>
</table>

*DASH, Dietary Approaches to Stop Hypertension; *LF Dairy*, low-fat dairy; *UF intake*, DASH-unfriendly food intake.
Scores in parentheses indicate *P* value
* *P* < 0.05
** *P* < 0.01
Analysis 4 estimated the effects of the intervention on changes in the psychosocial determinants by regressing changes in each psychosocial determinant onto the intervention (Table 5). The intervention was successful in significantly increasing knowledge ($P < 0.01$), self-efficacy ($P < 0.01$), and self-regulation ($P < 0.01$).

**Table 5. Effect of the Intervention on Changes in the Psychosocial Factor**

<table>
<thead>
<tr>
<th></th>
<th>Residual Change Score (mean ± SD)</th>
<th>Estimate (SE)</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>1.69 ± 1.20</td>
<td>3.52 (0.48)</td>
<td>7.28</td>
<td>&lt;0.0001**</td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td>-1.66 ± 4.35</td>
<td>-3.46 (1.29)</td>
<td>-2.70</td>
<td>0.0099**</td>
</tr>
<tr>
<td>Self-Regulation</td>
<td>0.77 ± 0.53</td>
<td>1.61 (0.18)</td>
<td>8.75</td>
<td>&lt;0.0001**</td>
</tr>
</tbody>
</table>

**$P < 0.01$**
Analysis 4 also estimated the independent effects of change in each of the psychosocial determinants on changes in dietary outcomes. This was done by regressing changes in the dietary outcomes and changes in each of the psychosocial determinants onto the intervention. These results are displayed in Table 6. Self-efficacy was the predominant mediator of changes in fruit intake ($P < 0.05$). Self-regulation was the predominant mediator of changes in low-fat dairy intake ($P < 0.05$). No psychosocial factor was able to significantly explain the increase in vegetable intake and decrease in DASH-unfriendly food intake.

**Table 6. Mediation Effects of Change in Psychosocial Factors on Change in Fruit, Vegetable, Low-Fat Dairy, and DASH-Unfriendly Foods**

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Psychosocial Factor</th>
<th>Estimate (SE)</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Knowledge</td>
<td>-0.18 (0.27)</td>
<td>-0.67</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>Self-Efficacy</td>
<td>-0.17 (0.08)</td>
<td>-2.19</td>
<td>0.04*</td>
</tr>
<tr>
<td></td>
<td>Self-Regulation</td>
<td>0.33 (0.66)</td>
<td>0.50</td>
<td>0.62</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Psychosocial Factor</th>
<th>Estimate (SE)</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Knowledge</td>
<td>-0.05 (0.34)</td>
<td>-0.15</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>Self-Efficacy</td>
<td>-0.14 (0.10)</td>
<td>-1.34</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>Self-Regulation</td>
<td>0.33 (0.84)</td>
<td>0.39</td>
<td>0.70</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Low-Fat Dairy</th>
<th>Psychosocial Factor</th>
<th>Estimate (SE)</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Knowledge</td>
<td>-0.06 (0.25)</td>
<td>-0.25</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td>Self-Efficacy</td>
<td>-0.04 (0.08)</td>
<td>-0.58</td>
<td>0.57</td>
</tr>
<tr>
<td></td>
<td>Self-Regulation</td>
<td>1.29 (0.59)</td>
<td>2.19</td>
<td>0.03*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DASH-Unfriendly</th>
<th>Psychosocial Factor</th>
<th>Estimate (SE)</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Knowledge</td>
<td>0.42 (0.55)</td>
<td>0.76</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>Self-Efficacy</td>
<td>0.08 (0.17)</td>
<td>0.51</td>
<td>0.62</td>
</tr>
<tr>
<td></td>
<td>Self-Regulation</td>
<td>-1.01 (1.38)</td>
<td>-0.74</td>
<td>0.47</td>
</tr>
</tbody>
</table>

* $P < 0.05$

*DASH, Dietary Approaches to Stop Hypertension; LF Dairy, low-fat dairy; UF intake, DASH-unfriendly intake.*

Adjusted for baseline BMI z-score, baseline systolic blood pressure, gender, and baseline kcal intake.
DISCUSSION

The DASH-4-Teens dietary intervention was designed based on the SCT (26). The aim of this study was to evaluate the effectiveness of a clinically-based intervention in mediating changes in three SCT constructs, which in turn were projected to influence changes in consumption of fruits, vegetables, low-fat dairy products, and DASH-unfriendly foods in adolescents with hypertension. Mediation analyses of change in psychosocial determinants (knowledge, self-efficacy, and self-regulation) on change in fruit, vegetable, low-fat dairy and DASH-unfriendly intake over a 3-month period were used to derive this information. This study is among the first to examine the mediation effect of specific psychosocial constructs of the SCT on changes in dietary intake of DASH foods in adolescents. Statistical analyses were performed using residual change scores. Residual change scores take into account the possibility that there are outliers, and are independent of baseline intake values. Use of residualized change score is a more conservative approach to examining overall change in dietary values between baseline and visit 2.

Results from this study showed that after 3 months, the DASH-4-Teens intervention was able to significantly mediate changes in all 3 SCT psychosocial constructs: knowledge, self-efficacy, and self-regulation. Mediation analysis showed that self-efficacy and self-regulation had significant mediating effects on fruit ($P < 0.05$) and low-fat dairy intake ($P < 0.05$), respectively. No psychosocial factor was found to explain the increase in vegetable intake or the decrease in DASH-unfriendly food intake.

According to the SCT, self-efficacy and self-regulation seem to be important determinants of decisions regarding dietary intake (14). Schnoll et al. (19) state that dietary
change requires active self-regulation of food intake, and is enhanced by combining goal setting and self-monitoring, two activities included in DASH-4-Teens (19). It is believed that subjects will only be successful in self-regulation if self-efficacy is enhanced (17). In this study, self-efficacy and self-regulation were the only 2 psychosocial determinants that had significant effects on dietary changes. However, these psychosocial determinants had mediation effects on only 1 dietary variable each, and on different dietary variables.

Self-efficacy was the predominant mediator of change in fruit intake \((P < 0.05)\) in this study. The DASH intervention targeted self-efficacy through curriculum activities with the adolescent (i.e. measuring portion sizes, label reading, menu planning, and identifying foods by food group). Perry et al. (45) state that a synergism of environmental changes, curriculum or knowledge interventions, and parental or family involvement is the most effective way to increase fruit and vegetable consumption. The self-efficacy component of the DASH intervention focused on many of these factors including changing the home environment by gradually building the teens confidence in identifying, preparing and shopping for DASH friendly foods. This may explain why self-efficacy was a predominant mediator of dietary change. It is not clear why fruit intake was the only dietary behavior that responded to increasing self-efficacy. One possible reason may be related to the adolescent’s liking of fruit more than other targeted foods in this study (e.g. vegetables, low-fat dairy). This has been observed by others (46). Self-regulation was the predominant mediator of changes in low-fat dairy intake \((P < 0.05)\). Self-regulation is necessary in dietary interventions because motivation alone is not sufficient to cause behavior change. For self-regulation to be successful, there must be realization of the need to change a behavior, development of skills, creating an action plan, learning the food and nutrition skills needed to achieve the action plan, monitoring progress, and
rewards when goals are achieved (6). These components were all addressed in the DASH-4-Teens intervention; emphasis on daily food monitoring, weekly goal establishment, and weekly non-food reward establishment. Low-fat dairy consumption was fairly low at baseline in both DASH (mean=1.29 servings/day) and control (mean=1.49 servings/day) completers. Constant monitoring of progress toward increasing low-fat dairy intake appeared to be important to modifying this DASH-related behavior.

Knowledge was unable to predict any changes in dietary consumption. This could be because knowledge was already high at the start of the intervention. This leaves little room for change. Knowledge is an important construct in the SCT, but does not always lead to health dietary behavior change (47). Knowledge of healthy foods to lower blood pressure does not always provide children with necessary skills to reach those dietary goals (i.e. self-efficacy and self-regulation).

A limitation of the study was that this was a pilot study and therefore had a small sample size. Increasing the sample size would possibly provide promising results in the ability of the DASH-4-Teens intervention to mediate changes in knowledge, self-efficacy, and self-regulation, which in turn may have stronger influences on changes in consumption of fruits, vegetables, low-fat dairy products, and high fat/high sodium foods (DASH-4-Teens Diet) in adolescents with hypertension. This pilot study was only 3 months long. Increasing the length of the study could influence positive changes in consumption of these foods as well because dietary changes happen over time and are not immediate.

Single-mediator analysis only was reported here (Table 6). Multiple-mediator analysis was conducted, but when the variables were placed in this analysis, the significant results
diminished. Haerens et al. (44) stated that both analyses should be conducted because the effect of a specific mediator in a multiple-mediator model may be obscured by the presence of multicollinearity (44). This is consistent with the results seen in this study. The lack of effect found in the multiple-mediator analysis may have been due to the strong correlation amongst the psychosocial factors (Table 4) and therefore may have obscured any relationship due to multicollinearity.

Although there are limitations, all 3 SCT constructs increased throughout the intervention and had some effect on improving dietary habits. This clinical intervention shows promise of being an intervention that can mediate changes in knowledge, self-efficacy, and self-regulation. Two of the constructs in turn influenced changes in consumption of fruits, and low-fat dairy in adolescents with hypertension.
REFERENCES


Appendix I

Diet and Blood Pressure Study: Knowledge Questionnaire

ID Number: ____________________________________________

Give the one best answer to each question.

1. How many servings of foods from the dairy group do I need each day?
   a. 5
   b. 2
   c. 3
   d. 1

2. Which food from the choices below would equal one serving from the dairy food group?
   a. 1 cup of milk
   b. ½ ounce of cheese
   c. ½ cup of yogurt
   d. 1 egg

3. A 3 oz. slice of turkey is equal to ____ servings from the meat group.
   a. 1
   b. 2
   c. 3
   d. 4

4. Which of the following food groups are high in potassium?
   a. Fruits
   b. Vegetables
   c. Fats & Oils
   d. Both a and b are high

5. _______is a nutrient in dairy foods that is believed to help lower blood pressure.
   a. Sodium
   b. Calcium
   c. Vitamin A
   d. Iron

6. To cut down on fat in your diet, you could:
   a. Use margarine instead of butter in most recipes.
   b. Eat more chicken instead of turkey.
   c. Drink skim milk instead of 2% or whole milk.
   d. Eat more fruits instead of vegetables.

7. The following is not a food in the dairy group.
   a. Low fat milk
   b. Ice cream
   c. Whole wheat bread
   d. Cottage cheese
8. Adding 1 cup of raisins to your breakfast would increase your daily fruit servings by how many?
   a. 1
   b. 2
   c. 3
   d. 4

9. Which of the following foods are not vegetables?
   a. Carrots
   b. Potatoes
   c. Peas
   d. Kiwi

10. Putting ½ cup of tomato sauce on a cheese bagel for lunch would give you ___________servings of vegetables.
    a. 1
    b. 2
    c. 3
    d. 4

11. Which of the following types of sandwiches is lowest in fat?
    a. Chicken salad made with mayonnaise on a roll
    b. Roast beef with mustard on whole wheat bread
    c. Ham and cheese with mustard on pumpernickel bread
    d. Sausage and peppers on a grinder roll

12. If a food says fat free on the label it is always low in calories?
    a. True
    b. False

13. Which method of cooking chicken is highest in fat?
    a. Grilling
    b. Frying
    c. Baking

14. Which type of vegetable is highest in sodium?
    a. Canned
    b. Fresh
    c. Frozen

15. The food label on a box of cereal says 100 mg of sodium for ½ cup. If you ate 1 cup of cereal, how many mg of sodium would you be eating?
    a. 100
    b. 200
    c. 150
    d. 300
Diet and Blood Pressure Study: Self-Efficacy Questionnaire

ID Number:_______________________________________

Please circle the answer that most closely matches how you feel about each sentence.

1. I can find the amount of total fat on a food label.
   Strongly agree neutral disagree strongly disagree

2. I can eat 3-5 servings of fruits each day.
   Strongly agree neutral disagree strongly disagree

3. I can reach goals that I set for myself and keep them for at least 1 month.
   Strongly agree neutral disagree strongly disagree

4. I can choose foods low in fat at the supermarket.
   Strongly agree neutral disagree strongly disagree

5. I can find the amount of sodium on a food label.
   Strongly agree neutral disagree strongly disagree

6. I can choose foods low in sodium at the supermarket.
   Strongly agree neutral disagree strongly disagree

7. I can eat 3-4 servings of vegetables each day.
   Strongly agree neutral disagree strongly disagree

8. I can eat healthy foods away from home (restaurant, school, friend’s house).
   Strongly agree neutral disagree strongly disagree

9. I can eat healthy foods when I’m by myself.
   Strongly agree neutral disagree strongly disagree

10. I can explain which foods in the diet are important to lower blood pressure.
    Strongly agree neutral disagree strongly disagree
Adolescent Skills Use Questionnaire

Please circle your answer to the following questions regarding what you did during the past 3 months. All questionnaires will be kept completely confidential, so please answer questions honestly. There are no right or wrong answers.

(Note: “Healthy foods” are those foods that are recommended by a nutritionist or other health professional to help lower your blood pressure.)

1. How often did you write down in a diary or log the foods you ate and drank?

   1 Never  2 Rarely  3 Sometimes  4 Often  5 Very Often

2. How often did you write down in a diary or log the number of servings or amounts of each food you ate?

   1 Never  2 Rarely  3 Sometimes  4 Often  5 Very Often

3. How often did you set goals for eating at least a certain number of fruits and vegetables?

   1 Never  2 Rarely  3 Sometimes  4 Often  5 Very Often

4. How often did you set goals for eating at least a certain number of low-fat dairy foods?

   1 Never  2 Rarely  3 Sometimes  4 Often  5 Very Often

5. How often did you set goals for eating no more than a certain number of salty foods?

   1 Never  2 Rarely  3 Sometimes  4 Often  5 Very Often

6. How often did you plan ahead for times when eating healthy foods might be hard?

   1 Never  2 Rarely  3 Sometimes  4 Often  5 Very Often
7. How often did you go back to eating healthy foods after a short period of time (for example, a few days or a week) when you did not eat healthy foods?

1 2 3 4 5
Never Rarely Sometimes Often Very Often

8. How often did you eat just a small amount of an unhealthy food when there was no other food choice available?

1 2 3 4 5
Never Rarely Sometimes Often Very Often

9. How often did you make a specific plan (or come up with a strategy) for eating at least a certain number of fruits or vegetables?

1 2 3 4 5
Never Rarely Sometimes Often Very Often

10. How often did you make a specific plan (or come up with a strategy) for eating at least a certain number of low-fat dairy foods?

1 2 3 4 5
Never Rarely Sometimes Often Very Often

11. How often did you make a specific plan (or come up with a strategy) for eating no more than a certain number of salty foods?

1 2 3 4 5
Never Rarely Sometimes Often Very Often