EFFECTS OF A FAMILY-BASED MONITORING TOOL ON FRUIT AND VEGETABLE CONSUMPTION

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ABSTRACT OF THESIS

Diets high in fruits and vegetables have been repeatedly shown to decrease one's risk of developing chronic diseases, yet data from the Centers for Disease Control estimate that only 32.5% of adults consume the recommended amount of two or more servings of fruit per day and only 26.3% adults consume the recommended amount of three or more servings of vegetables per day (2010). Behavior change techniques, such as self-monitoring, have been shown to be promising in changing daily eating patterns. Self-monitoring involves deliberate attention to one aspect of an individual's behavior, such as dietary intake and physical activity, and recording some details of that behavior.

The objective of this study was to develop and evaluate the effectiveness of a monitoring tool to increase fruit and vegetable intake in families. Families (n=6) were recruited from two different schools in Milwaukee, Wisconsin: Concordia University School – Pilgrim and Sherman Park Lutheran School. In this study, all families were in the intervention group. The main participant (mothers) from each family partook in an hour long education session on increasing fruit and vegetable intake. Participants learned how to estimate approximately how much fruits and vegetable each of their family members should be eating each day and then set a family fruit and vegetable goal. Participants were also shown how to use the monitoring tool and record its use. Data on current fruit and vegetable intake was gathered at baseline and at completion of the study by questionnaire.

At baseline, the average fruit intake of the children reported by the main participant was 1.5 ± 0.76 cups per day and the average vegetable intake was 1.17 ± 0.69 cups per day. For the main participants, the average fruit intake reported was 1.42 ± 0.45 cups per day and the average vegetable intake was 1.33 ± 0.37 cups per day. Two (33.3%) of the families completed the entire study. Both the children and the adults maintained the same average fruit intake of 1.5 ± 0.71 cups for the children and 1.75 ± 0.35 cups for the adults; however, both the children and the adults had an increase in average vegetable intake by 0.5 cups per day to post study totals of 1.25 ± 0.35 cups for the children and 1.75 ± 0.35 cups for the adults.

This study was limited in the number of enrolled participants as well as those who completed the study. However, the fruit and vegetable intake in both children and adults was below recommended amounts, and the monitoring tool may have a positive effect on vegetable intake.

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CHAPTER 1: INTRODUCTION

The United States Department of Agriculture (USDA) released the newest version of the Dietary Guidelines for Americans in 2010 and a new nutrition guide, MyPlate, in 2011 indicating the most recent healthy eating recommendations. The 2010 Dietary Guidelines for Americans provides specific recommendations on the foods and nutrients that should be consumed by Americans. One of the primary recommendations is to increase fruit and vegetable intake and widen the variety of vegetables consumed. These recommendations were developed to encourage consumption of adequate amounts of nutrients to promote the overall health of the population. The MyPlate icon depicts what a healthy plate should include at each meal with half of the plate being filled with fruits and vegetables.

Fruit and vegetable intake has been monitored for decades; unfortunately, the majority of Americans have never met the recommended levels (Casagrande, Wang, Anderson, & Gary, 2007). The Dietary Guidelines for Americans recommends at least five servings of fruits and vegetables a day for adults. Each serving, with exceptions for salad and dried fruit, is equivalent to a half cup of fruits or vegetables, and the five servings a day is the average number of servings needed to meet minimum nutritional needs (Dietary Guidelines, 2010). In 2009, an estimated 32% of adults consumed the recommended two or more servings of fruit per day and only 26% consumed the recommended three or more servings of vegetables per day (CDC, 2010). Additionally, evidence shows that many young children are consuming a diet inconsistent with United States Department of Agriculture (USDA) and the Department of Health and Human Services' recommendations. Children consumed on average about half the recommended

minimum of fruit servings and slightly more than half the minimum recommended vegetable servings (Spurrier, Magarey, Golley, Curnow, & Sawyer, 2008). Additionally, potatoes, most of them fried, accounted for more than a third of the vegetable servings. These findings indicate that there is a critical need for interventions to change behaviors associated with risk for obesity and chronic disease. One method of behavior change that has been described as the "cornerstone" of behavioral treatment approaches to weight control (Wadden, 1993; Baker & Kirschenbaum, 1993) is self-monitoring. Self-monitoring is a deliberate attention to some aspect of an individual's behavior, such as dietary intake and physical activity, by that individual, and recording some details of that behavior. To positively change behaviors, individuals need to pay adequate attention to their own actions, as well as to the conditions under which they occur, and their immediate and long-term effects (Bandura, 1998).

Van Achterberg et al. (2010) described self-monitoring as the technique most likely to contribute to successful behavior change in patient populations regardless of the health behavior at hand. Varying levels of self-monitoring behavior can be used based on individual needs. Some self-monitoring programs require clients to record their eating and exercise behavior using a high level of detail that is difficult for clients to maintain. While it may be effective, detailed self-monitoring is time consuming and, consequently, difficult to continue over time (Baker & Kirschenbaum, 1993).

The objective of this study was to find a simple and sustainable self-monitoring method for families to increase their fruit and vegetable consumption. Additionally, the long-term goal was to increase communication regarding food and food behaviors amongst family members and increase rates of family meal times.

Research Question

The question explored for this research study was, "will the use of a fruit and vegetable family-monitoring tool be associated with increased consumption of fruits and vegetables?"

Subproblems

This study also addressed the following research questions, "Will use of a fruit and vegetable monitoring tool be associated with a more positive attitude toward fruits and vegetables?" "What is the difference in fruit servings before and after use of tool?" "What is the difference in vegetable servings before and after use of tool?" "What is the difference in attitude to fruit & vegetable servings before and after use of tool?" "What monitoring tool is appropriate?"

Limitations

This study was small-scale and conducted primarily by one person. Only six families in total were recruited. Additionally, the task of self-monitoring daily is time-consuming, and only two families fully completed the study. The study was conducted over a short time period of three months. The study occurred during the summer when fruits and vegetables are more plentiful in Wisconsin and less expensive. All data collected was self-reported which could be biased.

Delimitations

The delimitations identified for this study include that families who participated must have at least one child between ages of 4 to 17 living in their home. Families with any children less than four years of age or with no children were excluded from the study. The families had to reside in Milwaukee, Wisconsin and speak English. Families had to be recruited during the time period May 15, 2013 to June 3, 2013.

Assumptions

For this study, the following assumptions were made:

1. The participants had at least one family member that can read, write, count, and record.
2. The participants were able to correctly identify fruits and vegetables.
3. The information on fruit and vegetable intake and lifestyle choices were understood by all participants.
4. The pre-and post-questionnaires were an adequate proxy to measure the nutrition knowledge, attitudes, and food consumption behaviors of participants.
5. All research participants completed the questionnaires honestly and correctly.

Definitions

1. Carotenoid: any of various usually yellow to red pigments found widely in plants and animals and characterized chemically by a long aliphatic polyene chain composed of eight isoprene units
2. Flavonoid: any of a group of oxygen-containing aromatic antioxidant compounds that includes many common pigments (such as anthocyanins and flavones)
3. Health Belief Model/Health Promotion Model: It is the balance of perceived barriers and perceived benefits or risk-benefits that predicts behavior change.
4. Proxy agency: a socially mediated form of agency exerted by youth when they try to get other people who have expertise or influence to act on their behalf to secure their desired outcomes.
5. Self-efficacy: A person's confidence in coping with barriers to change behavior; sense of control facilitates change.

6. Self-management: Engagement in self-monitoring of behavior influences behavior change.
7. Self-monitoring: deliberate attention to some aspect of an individual's behavior, such as dietary intake and physical activity, and recording some details of that behavior.
8. Social Cognitive Theory: Interaction among behavior, environment, and personal factors predicts behavior change (includes techniques such as modeling, skill training, self-monitoring, and contracting).
9. Social Learning Theory: Suggests that behavior is established in observing and imitating those with direct influence, reinforcement, and punishment.
10. The Transtheoretical Model/Stages of Change: Leading stage model in health behavior research; individuals reside at a given stage in relation to specific behavior change: precontemplation, contemplation, preparation, action, maintenance, and termination. Stage influences likelihood of behavior change.

CHAPTER 2: LITERATURE REVIEW

Introduction

Fruits and vegetables are typically lower-calorie, nutrient-dense foods considered to be critical components of healthy diets. Unfortunately, fruit and vegetable intake in the United States remains well below recommended levels, despite evidence of the health benefits of diets high in fruits and vegetables. Currently, the United States Department of Agriculture (2011) recommends that adult females consume 1 ½ to 2 cups of fruit and 2 to 2 ½ cups of vegetables each day to reduce risk for disease. They also recommend that adult males consume 2 cups of fruit and 2 ½ to 3 cups of vegetables daily. For children, females should consume 1 to 1 ½ cups fruit and 1 to 2 ½ cups of vegetables, while males should consume 1 cup to 2 cups fruit and 1 cups to 3 cups of vegetables (USDA, 2011). These recommendations may vary from person to person depending on the amount of physical activity they get.

For the past several decades, there has been a greater emphasis from public policy statements for Americans to increase fruit and vegetable consumption. Awareness of recommendations for fruit and vegetable consumption has increased substantially over the last 20 years (USDA, 2010). In 1991, about 8% of individuals reported being aware that fruit and vegetable intake should be at least 5 servings a day. In 2004, that number had increased to 40% (Stables, Subar, & Patterson et al., 2002). However, this heightened awareness has not translated into behavior change. Trends in consumption show that intake of fruit has not changed since 1988, and intake of vegetables has decreased slightly during the same period (Casagrande, Stark, Wang, Anderson, & Gary, 2007). Recent studies have estimated about 32% of adults consumed fruit two or more

times per day and only 26% consumed vegetables three or more times per day, far short of the Healthy People 2010 targets related to fruit and vegetable consumption among adults (CDC, 2010). Additionally, few children meet recommendation for daily fruit and vegetable intake; the USDA estimates only 25% of children consume the minimum number of fruit and vegetable servings per day (USDA, 2007). A review of the literature was conducted to evaluate and analyze current behavior change techniques to increase fruit and vegetable intake in children, adults, and families.

Background

Consuming a diet high in fruits and vegetables is associated with a decreased risk of many chronic diseases. Decades of research has shown that that those who consume low levels of these important foods have increased risk of chronic diseases such as heart disease, stroke, high blood pressure, diabetes and some cancers (CDC, 2010). In addition, mounting evidence suggests that consuming fruits and vegetables may place a role in weight management. Replacing foods of high energy density (high calories per weight of food) with foods of lower energy density, such as fruits and vegetables, can be an important weight management strategy (Tohill, Seymour, Serdula, Kettel-Khan, & Rolls, 2004). Increasing fruit and vegetable consumption among children is also desirable because eating habits are established in childhood and are predictive of adult intake patterns. Therefore, early intervention can maximize health benefits (Wardle, Carnell, & Cooke, 2005). Additionally, fruits and vegetables are good sources of many important nutrients that are under consumed in the United States including potassium, magnesium, folate, dietary fiber, and vitamins A, C, and K (USDA, 2010).

The importance of fruits and vegetables as part of healthy diets is also illustrated by the Dietary Guidelines for Americans 2010. These guidelines specifically recommend increasing fruits and vegetables and to "make half your plate fruits and vegetables" (USDA, 2010). Numerous approaches have been evaluated in an effort to identify the most effective strategies for increasing regular fruit and vegetable intake (CDC, 2010). These include, but are not limited to, worksite wellness programs, computer-tailored interventions, school-based interventions, church-based and other community-based programs, food policy councils/changed environments and access, counseling-based interventions, as well as healthcare interventions targeting primary prevention of disease or interventions among high-risk individuals diagnosed with a specific disease.

Increasing habitual intake of fruit and vegetables in the United States population to a level that meets current recommendations will require people to make significant daily changes in food choices. Behavioral interventions need to be optimized and combined with other approaches to establish habits that are sustainable. While behavior change may be challenging, it is possible and has been demonstrated previously with smoking cessation in the United States (CDC, 2010).

Several common behavioral theories and approaches have been utilized to promote change in health behaviors, including increasing fruit and vegetable intake. These interventions are delivered using a wide range of settings (schools, churches, community centers, day care centers, healthcare organizations, etc.), and with a variety of approaches including face-to-face counseling, group counseling, telephone-based delivery, printed materials, in-classroom instruction, garden-based learning, and computer-based technologies. Generally, these interventions have demonstrated small increases in intake

during the duration of the study, although the behavioral approaches providing the greatest increase in intake have not been clearly established.

The influence of the family on adolescent fruit and vegetable consumption is another important factor in changing behaviors. Studies have shown that parents and the home environment must be significantly involved in interventions promoting healthy nutrition through modeling of health behaviors; choosing, preparing and making healthy foods available; and encouraging and reinforcing healthy eating patterns (Pearson et al., 2008 & Gentile et al. 2009). However, the best method for involving families in promoting change in children's fruit and vegetable consumption is unclear (Pearson, Atkin, Biddle, & Gorely, 2010).

Interventions to Increase Fruit and Vegetable Intake in Children

As children spend most of their time in schools, schools are the most frequent targets for intervention programs aimed at preventing child obesity and increasing fruit and vegetable intake; however, the overall effectiveness of these programs has been limited (Thomson & Ravia, 2011). Therefore researchers recommend that interventions target multiple ecological levels (community, family, school and individual) to have greater success in increasing fruit and vegetable intake (Thomson & Ravia, 2011). Numerous studies have been conducted to examine the impact of interventions on increasing fruit and vegetable intake; these are critically reviewed below.

One novel way some researchers are trying to increase fruit and vegetable intake in children is through garden-based nutrition education programs. Heim, Stang & Ireland (2009) designed a 12-week pilot intervention to promote fruit and vegetable intake

among fourth, fifth, and sixth grade children attending a daily summer camp. A convenience sample of 93 children entering 4th to 6th grade were recruited from a 12-week YMCA summer camp to participate in the *Delicious and Nutritious Garden* intervention. The children participated in intervention activities twice per week for 20 to 30 minutes, that utilized social cognitive theory (SCT) and experiential learning principles. The principles of SCT emphasize that children's thoughts and beliefs about food can influence their behaviors. Children planted beans, beets, carrots, cabbage, cucumbers, eggplant, kohlrabi, leaf lettuce, okra, onions, peppers, radishes, strawberries, Swiss chard, summer squash, tomatoes, zucchini, and herbs in 25-foot by 25-foot plots during the first and second weeks of the intervention. Children also learned to weed, observe, and harvest their garden. Garden-based activities included learning about the origins of food, plant parts, nutrient needs of humans and plants, environmental stewardship, MyPyramid for Kids, goal setting, and role-playing. Each week children tasted a local fruit and/or vegetable from the farmers' market. Of the 16 fruits and vegetables presented during these taste tests, only six were not grown in the garden (spinach, sugar snap peas, apples, raspberries, cantaloupe, and watermelon). The origin, nutritional benefits, trivia questions, and ways to eat the fruit or vegetable were discussed. Prior to tasting, children were encouraged to look, smell, and feel the fruit or vegetable. In addition, the children prepared a dozen healthful snacks with produce from their garden. They also prepared snacks for younger campers to promote peer modeling of fruit and vegetable intake. All children received a cook- book containing recipes for the fruits and vegetables they taste-tested and prepared throughout the intervention. Children were encouraged to act as agents of change by sharing their experiences with

family members and asking for the fruits and vegetables they grew, tasted, or prepared during the intervention. Additionally, weekly newsletters, recipes, and take-home activities were sent home to parents and primary caregivers regularly.

Before and after the study, both parents and children were given a survey that analyzed whether children had ever eaten 11 specific vegetables and five fruits with the question, "Have you ever eaten this food?" The two response options were no or yes. At the end of the study, the children also received another survey that asked about their personal level of enjoyment for each intervention activity. Response categories were: disagree a lot, disagree a little, agree a little, or agree a lot. The survey also had four open-ended questions asking children to explain what they liked and disliked about the intervention, how they would improve it, and whether they would be interested in participating the following year.

Children reported high levels of enjoyment in the intervention activities. 97.8% of children reported they enjoyed taste-testing fruits and vegetables, 93.4% enjoyed preparing fruit and vegetable snacks, 95.6% enjoyed working in their garden, and 91.3% enjoyed learning about fruit and vegetables. Data also showed that the garden intervention led to an increase in the number of fruits and vegetables eaten. At baseline, more than two thirds of children had tried at least 75% of the 16 fruits and vegetables. Fewer than half of the children had ever eaten radishes, zucchini, or beets, whereas 90% of children had eaten lettuce, carrots, beans, apples, strawberries, raspberries, cantaloupe, and watermelon at baseline. At follow-up, children reported a significant increase in the number of fruits and vegetables ever eaten, specifically cucumbers, spinach, sugar snap peas, radishes, peppers, zucchini, beets, and cantaloupe. The authors concluded that

garden-based nutrition education programs can increase exposure to fruit and vegetables and improve predictors of fruit and vegetable intake through experiential learning activities. The authors recommended that food and nutrition professionals should consider garden-based nutrition education programs that connect children with healthful foods through fun, hands-on activities.

This study's strengths included the wide variety of activities provided to the children to increase their fruit and vegetable intake and the activities targeted to the parents or caregivers. However, the survey questions focused on specific fruits and vegetables that the researchers knew were provided during the intervention, which seems biased.

Dzewaltowski, et al (2009) evaluated the effects of the Healthy Youth Places (HYP) intervention that targeted increased fruit and vegetable consumption and physical activity through building the environmental change skills and efficacy of adults and youth. Sixteen schools were randomized to either implement the HYP program or to a control group that did not complete any program, but completed the baseline and post-intervention assessments. The multilevel intervention model was designed to target the development of the personal and proxy agency of adult leaders and youth to build middle school environments (healthy places) that promote fruit and vegetable intake and physical activity. The intervention model was designed to encourage the participants by building youth self-efficacy for fruit and vegetable intake and physical activity. Proxy agency is a socially mediated form of agency exerted by youth when they try to get other people who have expertise or influence to act on their behalf to secure their desired outcomes. The intervention model was designed to influence proxy efficacy by building youth's

confidence that they could inspire teachers and parents, to assist them in building healthy places. HYP included group training for adult school site leaders, environmental change skill curriculum, and youth-led fruit and vegetable and physical activity environment change teams.

At the project level, expert staff delivered continuous group staff training intervention to paid school site coordinators from the eight intervention schools. For the group staff training, school site coordinators from the eight intervention schools were linked together as part of a "performance community hub" to facilitate sharing and problem solving. They attended four training sessions yearly and participated in monthly conference calls. These training sessions (with periodic e-mail, phone, video and web support) emphasized theory-based principles of behavior change and strategies to engage students in advocacy for physical activity (PA) and fruit and vegetable (FV) environmental change. Key youth and adult place leaders (individuals with a high degree of responsibility and involvement in the targeted classroom, school lunch, and after-school program) were participants on the school change teams. The school change teams created awareness and visibility within their school regarding the importance of physical activity and good nutrition. In addition, a video workgroup at each intervention site developed site-specific videos that highlighted ways students could incorporate FV and PA into specific school settings such as in the classroom, school lunch and after school programs.

In the classroom, seventh and eighth graders participated in a specific curriculum entitled "Students Building and Promoting Healthy Places" that targeted building the knowledge and skills for environmental change and facilitated student leadership. The

seventh grade curriculum consisted of eight lessons that introduced students to the planning process and steps to environmental change and taught youth environmental change skills (team work and collaboration, physical activity and fruit and vegetable consumption information gathering, analysis of environmental change plans and efforts, and communication and marketing). The eighth grade curriculum consisted of four lessons that reinforced the place-base planning process and youth planned environmental changes in both school lunch and after school programs.

At 16 schools, 1,582 participants were assessed on fruit and vegetable intake and physical activity time as well as the proxy efficacy using a validated questionnaire at the end of sixth (baseline), seventh (post-intervention year one), and eighth grades (post-intervention year two). At post-intervention year two, there was a significant increase ($p < 0.05$) in physical activity for those at the intervention schools compared to students at the control schools. Children in intervention schools increased in vigorous physical activity by an average estimated 3.7 percent during the after school hours compared to baseline. However, HYP schools did not have significant change in fruit and vegetable intake compared to baseline, but several schools made important changes in school lunch quality. Intervention students' group norm for fruit and vegetable consumption increased compared to control schools by the end of the study. Although schools were managed at the site, school food service decisions were sometimes controlled at the district level, so changes in these environments may have required an additional district-level intervention.

The authors concluded that an intervention designed to build the skills and efficacy of adult school leaders and youth increased proxy efficacy to change school

environments and influenced the physical activity of middle school students. The authors also concluded that if public health behavior change experts target the capacity of others to influence through a multilevel intervention model, one expert or a small group of experts may be able to influence others with an intervention that has both effectiveness and reach.

The strengths of this study included the training provided to the educators. The program emphasized building the capacity of school staff to create environmental change rather than on the implementation of a specific curriculum or program. The intervention placed youth in a leadership role to help change the school lunch and after school environments. There was no significant change in fruit and vegetable intake; additional work is needed to determine how to increase fruit and vegetable consumption. The authors did point out that the food frequency questionnaire used to measure fruit and vegetable consumption may not have been sensitive enough to measure change – particularly because the new food offerings at some schools were not specifically listed as a food choice on the instrument.

The United States Department of Agriculture (USDA) piloted a Fresh Fruit and Vegetable Program (FFVP) in 2002 with the objective of improving fruit and vegetable intake among children and adolescents. Qualitative outcomes of the pilot study suggested that students were exposed to a large variety of fresh fruits and vegetables and school staff reported it also may have reduced students' obesity risk as well as increased students' awareness, preference, and intake of fruits and vegetables. Davis, Weber Cullen, Watson, Konarik & Radcliffe (2009) decided to assess the impact of the program at one Houston area high school when the school was selected to participate in the

USDA's FFVP program during 2006 and 2007. The school received funding to provide daily fresh fruit and vegetable snacks to all students. An additional high school in the school district served as the comparison school.

Fresh fruit and vegetable snacks were provided to the students for three semesters: Spring and Autumn 2006, and Spring 2007. School foodservice staff prepared a basket of fresh fruit or vegetables daily for each of the 180 homeroom teachers in the school. Some of the fruits and vegetables served included pineapple, kiwi, oranges, pears, plums, several varieties of apples, and raw carrot and celery sticks with low-fat ranch dip. Teachers collected the baskets each morning and their students were allowed to select and eat the items in the classroom as long as the supply lasted. The teachers were also encouraged to talk about fruits and vegetables in their classrooms.

At the end of the program, fruit and vegetable intake surveys were distributed to students at the intervention school and at the control high school. The anonymous survey included demographic questions about gender, grade level, and ethnicity. Fruit and vegetable intake data were collected with seven questions from the Youth Risk Behavior Surveillance System. Students were asked, "During the past seven days, how many times did you eat" fruit (not including juice), green salad, carrots, other vegetables (not including potatoes), potatoes (not including French fries, fried potatoes, or potato chips), French fries or fried potatoes (not including potato chips), and 100% fruit juice such as orange or apple juice (not including punch, sport drinks, or fruit-flavored drinks). Response options were: 0, 1 to 3 times, or 4 to 6 times in the last 7 days; 1 time per day; 2 times per day; 3 times per day; or 4 or more times per day. Students were also asked how often they ate a fruit or vegetable in the classroom and whether they tried any fruits or

vegetables that were new to them. Teachers were asked to report what type of nutrition education was conducted in their classes during the intervention period.

A total of 2,080 intervention (43% of school population) and 1,610 comparison (46%) school students returned surveys. However, only students who provided demographic information and fruit, juice, and vegetable intake data were included in the statistical analyses. In total, 1,515 intervention (34%) and 1,377 comparison school students (42%) were included. Approximately 20% of the high school students from both schools reported eating five or more servings of fruit, juice, and vegetables each day. In particular, vegetable consumption was low, with only about 13% meeting the guideline of consuming vegetables three or more times per day. Compared with control school students, significantly more intervention school students reported eating fruit and 100% fruit juice at least two times per day (39.3% vs. 27.3%; $P<0.05$); total fruit, 100% fruit juice, and vegetables (excluding French fries) five or more times per day (22.0% vs. 18.4%; $P<0.05$); and fruit at least one time per day (59.1% vs. 40.9%; $P<0.05$) in the preceding 7 days. There were no differences in the percentage of students eating vegetables three or more times per day. After controlling for demographic characteristics, only the whole fruit intake and 100% fruit juice intake differences remained significant ($P<0.05$) due to almost 60% of intervention school students reported eating at least one fruit per day, compared with 41% of the comparison school students, The authors concluded that it was likely the increased availability of fruit in the classroom that was responsible for the significant difference in intake of total fruit, juice, and vegetables. Additionally, 35% of the intervention students reported eating a fruit or vegetable in the classroom every day; 33% reported eating a serving two to three times per week, whereas

only 11% reported never eating a fruit or vegetable in the classroom.

The strengths of the study were that it was simple and utilized a program already being conducted by the USDA. However, while USDA's Fresh Fruit and Vegetable Program is open to all elementary schools, those with more students that qualify for free and reduced price lunches are more likely to receive the funding to conduct it. Additionally, each school has the discretion to pick which fruits and vegetables to serve, how often to serve them, and when to serve them; this could potentially affect the program's effectiveness across the board. Another weakness was that the nutrition education provided by the teachers wasn't mentioned in the results. It is likely that results would vary greatly between schools utilizing the USDA's FFVP due to many different variables.

The Mississippi Department of Education Child Nutrition Program also evaluated the effects of a similar Fresh Fruit and Vegetable Program during the 2004-2005 school year (Coyle et al, 2009). Their program was designed to: 1) increase student access to fresh fruits and vegetables; 2) increase the degree of student preference for fruits and vegetables; and 3) increase fruit and vegetable consumption. Schools in Mississippi (n=25) received funding to buy and distribute free fresh fruit and vegetable snacks (e.g., apples, oranges, carrots, and celery) during the school day. Schools distributed the snacks in classrooms or in a central area in baskets, trays, and carts. Teachers and school personnel (e.g., nutrition services staff) typically distributed the snacks at morning break. In addition, schools used a variety of promotional and supplemental educational activities throughout the school year to promote program awareness and encourage students to try new fruit and vegetable snacks (e.g., food tasting events, newsletters, promotional

posters, and classroom lessons).

Five of the schools were selected to complete an evaluation. All students in grades five, eight, and ten from the evaluation schools completed a pre- and posttest administered in the fall and spring, respectively, to evaluate the program. The pre- and posttests assessed changes in the following during the school year: 1) the variety of fruits and vegetables ever eaten by students, 2) their attitudes toward fruits and vegetables, 3) their willingness to try fruits and vegetables, 4) their degree of preference for fruits and vegetables, and 5) their intentions to eat fruits and vegetables. Additionally, registered dietitians and trained nutrition interviewers from Mississippi collected 24-hour dietary recall data from selected students in grades eight and 10. They administered one-on-one interviews in a private location (e.g., school library) during school hours. They used props such as two-dimensional food model cards and measuring cups to help participants complete the interviews.

Results indicated the variety of fruits and vegetables eaten increased significantly from baseline to the end of the program among students in all three grades. Only 8th grade students, however, had significant increases in positive attitudes toward eating fruits and vegetables (e.g., they indicated they believed they could eat more fruit and that they were willing to try new fruit). Intention to eat fruit increased significantly among tenth grade students compared to baseline, but not among fifth grade or eighth grade students. Student consumption of fruit in the school and overall increased significantly ($p<0.01$) by 0.34 and 0.61 servings per day for the eighth grade and tenth grade students who participated in dietary recall interviews. The authors concluded that the results from the Fresh Fruit and Vegetable Program indicated that fresh fruit and vegetable

distribution programs provide the opportunity for students to taste a variety of fruits and vegetables and may improve consumption of some of these foods by adolescents. Additionally, they found the program to be more successful with the students in grades eight and ten than those in fifth grade. The elementary school students' willingness to try and preferences for new fruit and vegetables actually decreased.

Weaknesses of the study include that there was no control or comparison group. Without a comparison group, the influences of factors such as seasonality, national attention on the issue of obesity, or other unknown trends cannot be ruled out. Additionally, they only took a small sample of students to collect dietary recalls, which may not have been a good indicator of the entire population. There was a high participation and retention rate in both the student surveys and 24-hour recall interviews.

Communication technology is another novel way we can help stimulate youth to eat more fruits and vegetables. Di Noia, Contento, & Prochaska (2008) examined the efficacy of an intervention based on the transtheoretical model (TTM) for increasing fruit and vegetable consumption among economically disadvantaged African-American adolescents. The study was conducted in 27 youth services agencies located in urban areas of New York, New Jersey, and Pennsylvania. Youth services agencies were private nonprofit organizations that provided human services, such as school dropout prevention, recreation, educational tutoring, computer literacy training, and youth club activities. Outcome data were collected using a quasi-experimental research design. Agencies matched on the size of their youth population were randomized to one of two conditions: computer intervention (CIN) and control. A total of 507 African-American adolescents aged 11 to 14 years participated. Youths in both groups were administered pre-tests to

determine their current fruit and vegetable intake level as well as to evaluate what stage of change they were in. Two weeks after pretesting, all users completed an introductory session, which oriented them to the program and addressed the health benefits of consuming five or more daily servings of fruits and vegetables. In addition, youths in the CIN group completed four 30-minute intervention sessions tailored on TTM stages and processes of change. A staging measure built into the session classified users into precontemplation, contemplation/preparation, or action/maintenance. Users' stage classification determined which group of three additional intervention sessions they would complete. Youths in the control arm participated in regular programs offered at collaborating sites. Two weeks after intervention, youths in the CIN and control arms completed post-tests.

At baseline, the largest proportion of youths was classified in contemplation/preparation (55%), followed by pre-contemplation (33%) and action/maintenance (12%) stages. Participants' mean (SD) level of consumption at study entry was 2.54 (1.48) servings. After adjustment by covariates, fruit and vegetable consumption ($p < 0.001$) and pros of change ($p < 0.025$) varied significantly between the intervention group and the control group. Group means revealed that youths in the CIN group had significantly higher mean intake (mean: 3.25 servings, SD: 1.50 servings) and pro scores (mean: 51.80, SD: 9.89) than youths in the control group (mean: 2.46, SD: 1.39 servings, and mean: 49.21, SD: 9.89 servings, respectively, $p<0.05$). The authors concluded that a TTM and computer-based intervention can increase fruit and vegetable intake and result in positive changes in TTM variables related to intake among economically disadvantaged African-American adolescents.

The six studies discussed evaluated programs designed to increase fruit and vegetable intake in children and adolescents. The programs used many different methods such as incorporating garden and nutrition education in community programs, training students to become leaders to make schools healthier, increasing fruit and vegetable access in schools, and creating online learning modules. All six studies demonstrated that programs were modestly effective suggesting that people may be responsive to different approaches. There are many different factors that influence eating behavior, such as fruit and vegetable availability, peer influences, nutrition knowledge and beliefs, mass media, and parental dietary habits. Unfortunately, it's hard to target them all with one intervention; different approaches may be effective depending on the barrier to adequate intake. Regardless, interventions that start at an early age are important as most eating habits are shaped in younger ages.

Interventions to Increase Fruit and Vegetable Intake in Adults

Research on programs for increasing fruit and vegetable intake in adults was also evaluated as interventions for adults tend to differ from those designed for children.

Alexander, et al. (2010) assessed change in fruit and vegetable intake in a population-based sample, comparing an online untailored program (arm one) with a tailored, online dietary behavioral intervention to increase fruit and vegetable intake (arm two) and with a tailored behavioral intervention plus motivational interviewing–based counseling via e-mail (arm three) in a program called Making Effective Nutritional Choices (MENU). The Web-based MENU program content was based on principles from Social Cognitive Theory, the Transtheoretical Model, and the Health Belief Model. Constructs. In arm two and arm three, the program was tailored by assessing each participants' specific motives for changing (e.g., health improvement, weight loss, role modeling), barriers to changing (e.g., expense of produce, inadequate cooking skills, disliking the taste), and cues to action (e.g., participants were told to keep produce in

sight, program provided recipes). Participants were matched by health plan, gender, and baseline stage of change (a measure of reported readiness to change, ranging from no intention to change [precontemplative] to already making changes [action]) and were randomly assigned to one of the three experimental arms. Across all arms, the Web program had the same layout and design and had similar content, which was written at the sixth- to seventh-grade level. The tailored Web site's content matched needs, dietary preferences, and interests expressed in the baseline and three-month surveys. The control arm provided general fruit and vegetable nutrition information without any tailoring. Participants who enrolled were aged 21 to 65 years from five health plans in Seattle, Washington; Denver, Colorado; Minneapolis, Minnesota; Detroit, Michigan; and Atlanta, Georgia. They measured participants' self-reported intake of fruits and vegetables at baseline and at three, six, and 12 months. Of 2,540 trial participants, 80% were followed up at 12 months. Overall baseline mean fruit and vegetable intake was 4.4 servings per day. Average servings increased by more than two servings across all study arms ($P < 0.001$), with the greatest increase (+2.8 servings) among participants of arm three ($P = 0.05$, compared with control). Overall program satisfaction was high and follow-up participation rates were 86% at three months, 80% at six and 12 months. The authors concluded that their online nutritional intervention was well received, convenient, easy to disseminate, and associated with sustained dietary change. Programs such as these have promise as population-based dietary interventions.

Some of the limitations of this study were that only people with Internet access were eligible and able to complete the study. The strengths of this study were its randomized design, long-term follow-up, high retention rates throughout the 12-month

study period, and participant diversity.

Telephone interventions are another common way to help promote behavior changes without requiring huge amounts of time or money for the patient or provider. Djuric, Ellsworth, Ren, Sen, & Ruffin (2010) examined the feasibility of eliciting dietary changes in subjects recruited from a diverse primary care setting in Michigan. The goal of the study was to increase fruit and vegetable consumption by at least 2 servings per day without a change in overall energy intake.

A total of 96 subjects were enrolled, 49% of whom were minorities. Subjects were randomized to one of three groups for 3 months: 1) education materials only, 2) education materials and a form for formulating a plan for dietary change (with no oral instructions), and 3) education materials, written plan, and telephone counseling using three calls. Subjects were not told of their randomization assignment until after one un-announced 24-hour dietary recall was completed by phone. Subjects were then randomized across the three groups and the appropriate materials were mailed to each subject. The four-page education hand out given to all subjects contained the following information: USDA dietary recommendations and how to substitute fruits and vegetables for less nutritious foods (including examples of substitutions); how fruit and vegetables can maintain health; lists of fruits and vegetables in color categories, with their approximate caloric values; and lists of less healthful foods that could be omitted from the diet, in categories based on their caloric content. Fruits and vegetables were divided into five categories to emphasize the variety of carotenoids and flavonoids that they contain using the Rainbow color scheme developed for the 5-A-Day Program (Produce for Better Health Foundation).

The information on energy content of common foods that are less nutritious was presented to facilitate substitutions, since adding 75 kcal/day from two servings of fruit and vegetables could result in a weight gain of 7.8 lb/year if not compensated for. These extra calories from fruits and vegetables was recommended to be accommodated by replacing or reducing snacks (such as potato chips, soda, cookies, etc.) or by avoiding or reducing added fats to foods (such as mayonnaise, butter, gravy or salad dressing). The written plan was done on a two-part carbon form and given to subjects randomized to Groups two and three. A brief paragraph on the form stated that there is nutritional value in replacing high fat and sugary foods that contain few nutrients with fruits and vegetables that are high in nutrients. Below that, subjects were asked to answer three questions: how to go about eating less of a less nutritious food, how to eat at least one more serving of vegetables and how to eat at least one more serving of fruit each day. Subjects randomized to Group three also received three counseling phone calls from a registered dietitian and a small log book that included check boxes for monitoring consumption of fruit, vegetables and less nutritious foods. Each booklet was sufficient for tracking one month of intake, and each subject received three booklets. Calls were scheduled to be completed one week, one month and two months after baseline. The calls consisted of reviewing the written plan, reviewing self- monitoring logs and noting any progress made toward that goal. They also reaffirmed the importance of fruit and vegetable consumption on health. Subjects who were not completely successful were encouraged to identify barriers in meeting their plans and to develop strategies to overcome those barriers. Subjects successful in meeting their goals were asked to verbalize a plan on how they planned on continuing with their success.

Subject retention was 76% for the 12-week study. Subjects in Groups one, two and three increased their mean intakes of fruit and vegetables from baseline by 0.4, 0.7 and 1.4 servings/day, respectively. Participants in Group three lost an average of 0.73 kg, increased their perception of the importance of eating fruits and vegetables, and 63% increased their serum levels of carotenoids by 20% or more. The authors concluded that the formulation of a written plan combined with telephone counseling appears to be promising for improving fruit and vegetable intakes although it warrants more definitive study. They suggested that such studies, should include dietitian support to help individuals form a concrete plan to consume more fruits and vegetables, and should establish optimal number of contacts needed to increase fruit and vegetable intake to optimal levels.

Wolf, Lepore, Vandergiff, Basch, & Yaroch (2009) examined the effects of tailored telephone education calls to increase fruit and vegetable intake. They recruited 490 urban, primarily immigrant, black men from the New York City metropolitan area participating in the Cancer Awareness and Prevention (CAP) Trial. The men were randomly assigned to one of two intervention groups: 1) Fruit and Vegetable Education or 2) Prostate Education. For both interventions, participants received a mailed brochure plus two tailored telephone education calls.

After eight months, the Fruit and Vegetable Education group consumed an average of 1.2 more fruit and vegetable servings per day than the Prostate Education group ($P<0.001$; adjusted for baseline). The Fruit and Vegetable Education group also demonstrated increased knowledge about recommended fruit and vegetable serving amounts ($P<0.01$) and appropriate serving sizes ($P<0.05$), and in the percent of

participants moving from a lower to a higher stage of readiness to adopt fruit and vegetable recommendations ($P<0.05$). However, the Fruit and Vegetable Education group did not demonstrate an increase in knowledge related to the importance of eating a colorful variety or in the ability to name potential health benefits of produce.

Another telephone intervention to promote weight-related health behaviors by Kim, Pike, Adams, Cross, Doyle, & Foreyt (2010) evaluated the use of the Nutrition and Physical Activity (NuPA) study, which was designed to promote fruit and vegetable consumption, physical activity, and weight management for a working population.

Participants from all over the United States were recruited; 2,470 employed participants were randomized into the self-help (SH: n=1,191) or self-help plus telephone counseling (SH+C: n=1,279) group. The self-help group received print materials with information on increasing fruit and vegetable intake, increasing physical activity, and managing their weight. The SH+C group received all of the print materials plus nine structured telephone counseling sessions. The authors found that the SH+C was effective in increasing fruit and vegetable consumption. Among the overweight and obese participants, weight loss was significant in both the SH and SH+C groups. The authors concluded that using a theory-based behavioral change counseling technique and targeting multiple health behaviors among employed individuals through use of telephone and mailings can be an effective way to promote a healthy diet and weight management.

Five published studies looking at interventions aimed at increasing fruit and vegetable intake in adults were reviewed. Most of these studies involved using a communication device to communicate with the subjects rather than by direct face to face contact. These studies showed that in-person education and communication is not needed

to have effective results in increasing fruit and vegetable intake in adults.

Interventions to Increase Fruit and Vegetable Intake in Families

Interventions targeted to children and adults have been analyzed. Studies aimed at the family unit were also evaluated to compare how interventions may differ when trying to increase fruit and vegetable intake in both children and adults.

Haire-Joshu (2008) tested the effectiveness of the High 5 for Preschool Kids (*H5-KIDS*) program. This study was a group randomized, nested cohort design and was implemented from 2001 to 2006. A total of 1,658 families with a preschool-aged child (ages 2 to 5 years old) participated in the *H5-KIDS* study; 899 control families received the standard Parents As Teachers (PAT) program, a national parent education program and 759 intervention families received the standard PAT program plus the *H5-KIDS* protocol. *H5-KIDS* is a home-based intervention to teach parents how to ensure a positive fruit-vegetable environment for their preschool child, and to examine whether changes in parent behavior were associated with improvements in child intake of fruits and vegetables (FV). *H5-KIDS* used a combination of theoretical models to guide development including social cognitive theory and an ecological framework. Intervention strategies targeted the intrapersonal environment of the parent (e.g., knowledge, FV servings), interpersonal interactions between the parent and child (e.g., child-feeding practices, FV modeling), and the physical environment (e.g., FV availability in the home). *H5-KIDS* was comprised of three components: a tailored newsletter, a series of home visits, and materials for the parent and child, including storybooks.

Parents received tailored newsletters that were devised from a pretest interview. Each newsletter began with a bulleted tailored statement that included the self-reported servings of FVs the parent and the child consumed per day. Additional parent data (e.g. FV knowledge, parental role modeling, non-coercive parenting skills, FV availability assessed by a pre-test were each uniquely used to individualize messages and describe the themes of each of the four storybook sets the family would receive at their home visits. For example, if participant data indicated a parent did not eat FV in front of their child very often (<7/week), the tailored messages would emphasize the importance of modeling FV intake in front of the child as a means of improving consumption, and provided relevant examples of how this could be accomplished. The parent was then referred to *H5-KIDS* storybooks that provided examples of modeling for the child. In contrast, parents who scored appropriately in each individual area received messages of praise encouraging them to continue their behaviors. Newsletters were mailed to the parent's home at the beginning of the program.

Parent educators conducted four *H5-KIDS* home visits, each of which addressed the core program areas (knowledge, parental modeling of FV intake, non-coercive feeding practices, FV availability). Parent educators then reinforced the core content in subsequent visits. As part of each visit, parents also received materials and informational handouts with suggestions for improving feeding practices and the food environment in the home. Additionally, at each visit, children received a *H5-KIDS* sing-a-long storybook with audio cassette tape and a coloring book. Each storybook reinforced one of the core areas of the *H5-KIDS* program through the use of child friendly characters and appealing storylines presented through songs.

A telephone survey was conducted with the same parent before and after the intervention to assess change in the dietary patterns and behaviors of both preschool children and the parents. Body mass index was calculated from height and weight reported by the parent for themselves and their child. The average time between the pretest and the posttest survey was seven months but ranged between six and 11 months. Participants were given a $20 gift card for completing the pretest and posttest survey. Child and parent FV intake was assessed with the Saint Louis University for Kids Food Frequency Questionnaire (SLU4Kids FFQ). The SLU4Kids FFQ was developed by selecting specific cancer preventive FV that were available to and more likely to be consumed by members of the target demographic (rural Midwest, children ages 2–5 and parents ages 20–59). Additionally, a sub-sample of respondents was re-interviewed shortly after the initial baseline interview to establish test-retest reliability for the measures in this population. The SLU4Kids FFQ examined child and parent intake of 27 FV during the past seven days, as well as the child's preference for specific FV. FV intake over the seven days was converted into the number of times consumed per day for each individual food item and summed to obtain the total number of fruits (excluding juice), vegetables (excluding fried potatoes), and FV combined. The test-retest reliability for the measures of fruit and vegetable preference were excellent with intraclass correlation coefficients (ICC) of 0.78 and .84 respectively. The measure of FV intake showed excellent reliability with a test-retest ICC of .82.

Parental use of coercive child-feeding practices (e.g. using food as a reward) was evaluated by four items that summed the number of "rarely" or "never" responses (range, 0–4; test-retest ICC = 0.66). Modeling of FV intake was assessed by asking parents the

number of times in the prior week that their child had observed them eating FV (test-retest ICC = 0.50). Nutrition knowledge was assessed by asking the number of times a child should eat fruits and vegetables for good health, and number of times a child needed to be exposed to a food before developing preference (test-retest ICC = 0.65 and 0.74 respectively). FV availability in the home was assessed as the number of specific food items (fruit cocktail, broccoli, tomatoes, mixed vegetables, cantaloupe, strawberries, carrots, and green beans) present in the home during the past week (range, 0–8; test-retest reliability ICC = 0.71).

The *H5-KIDS* program was delivered in its entirety to 78% of intervention families. Parent educators reported a high degree of acceptance for all four *H5-KIDS* modules, as indicated by the proportion who responded "strongly agree" or "agree" to the following items: content was relevant to parent's current situation (90%), parent actively participated in discussions (91%), parent and child responded positively to materials (94%), and materials/activities reinforced *H5-KIDS* content (95%). In addition, 97% of parents felt that their parent educator knew a lot about nutrition.

Among participating families, 84% completed the posttest survey, but participants were excluded from the posttest if there was missing or inconsistent data (n=81) leaving a sample of 1,306 families (79%) with 605 in the intervention group and 701 in the control group. Overall, 95% of participants were mothers, and intervention group parents were more likely to be white, younger, less educated, and have lower income than control group parents.

When compared to control parents, *H5-KIDS* parents significantly improved intake of fruit alone (increase in mean servings per day of .14 (p=0.04) and combined FV

increase in mean servings per day of .20 (p=0.05). *H5-KIDS* parents also reported an increase in FV knowledge and availability of FV within the home (p=0.01). However, vegetable preference decreased in both control and intervention groups but to a significantly lower degree among *H5-KIDS* children. The effectiveness of the intervention for *H5-KIDS* children differed by the child's weight status at baseline. Fruit servings, vegetable servings, and combined FV servings increased in normal weight (0.35, p=0.02), but not overweight children (0.10, p=0.48). Logistic regression controlling for age and parental education indicated that normal weight intervention children were 1.49 times more likely than controls to increase their intake of fruits and vegetables by half a serving per day or more (O.R. 1.01–2.20).

Parent's change in FV servings was a significant predictor of child's change in FV in the *H5-KIDS* group. An increase of one FV per day among parents was associated with an increase of 0.50 FV per day among children. The intermediate outcomes of FV availability and knowledge also predicted positive change in child's FV servings.

The authors concluded that *H5-KIDS* improved the fruit intake of parents, and FV knowledge and availability in the home. When *H5-KIDS* parents increased their FV intake, their child's intake improved as well. Thus *H5-KIDS* provided evidence for the importance of intervening with parents in real world settings as important gatekeepers who control the food environment of their young child. Additionally, the authors thought it showed how important early parent intervention can be to prevent childhood obesity as *H5-KIDS* was more effective in improving FV intake among normal weight children than those who were overweight.

The strengths of this study included the randomized design and the large amount of outcome data on a group of understudied parents with preschool children. However, the population sample and the self-reporting and parent-reporting on behalf of children contributed to the weaknesses of this study.

Gentile et al. (2009) examined the immediate and short-term effects of the "Switch® what you Do, View, and Chew" program. This family-based program targeted three behaviors: screen time, physical activity, and fruit and vegetable intake. The specific DO, VIEW, and CHEW goals were to be active for 60 minutes or more per day, to limit total screen time to two hours or fewer per day, and to eat five fruits/vegetables or more per day. The intervention aimed to influence three areas: the family, school, and community.

Participants included 1,323 children and their parents from ten schools in two states. Schools were matched based on size and demographic data and randomly assigned to treatment and control groups. Measures of the three key behaviors and body mass index were collected at baseline, immediately post-intervention, and six months post-intervention. Parents and children reported fruit and vegetable consumption with items adapted from the National Youth Risk Behavior Survey. The items evaluated the child's frequency of drinking 100% juice, sugared drinks, eating fruit, green salad, carrots, and other vegetables. Parents reported consumption over the previous seven days and children reported for the previous day.

The experimental group showed a significant increase (t (340) = 3.05, $P < 0.01$) in parent-reported fruit and vegetable consumption compared to baseline, while child-reported fruit and vegetable consumption was marginally significant. At the six-month

follow-up, parent and child-reported fruit and vegetable consumption significantly increased from baseline ($p<0.05$). The perception of change among the experimental group was generally positive, with 23% to 62% indicating positive changes in behavior. The authors concluded that the Switch program yielded small-to-modest treatment effects for promoting fruit and vegetable consumption.

The two studies showed that interventions in families can be just as effective as or even more effective than interventions aimed at children or parents alone. Children look to parents to model behavior and provide the food that they eat so ultimately if parents are purchasing fruits and vegetables, providing fruits and vegetables at meals, and eating them in front of their children, their children will tend to emulate these behaviors and therefore increase their fruit and vegetable consumption.

Interventions to Increase Fruit and Vegetable Intake Using Self-Monitoring Tools

Self-monitoring tools are a way to increase fruit and vegetable intake long-term by assisting in behavior change. Studies that utilized self-monitoring tools for dietary intervention were reviewed.

Achyara et al. (2011) analyzed the use of self-monitoring on a personal digital assistant (PDA) with dietary software compared to a standard paper record (PR). The study purpose was to describe and compare dietary changes between PR and PDA groups at six months in a behavioral weight loss treatment in overweight/obese adults.

The study sample included 192 overweight/obese adults (mean body mass index 34.1 kg/m2) aged 18 to 59 years old with an average, 15 years of education who had adequately completed a 5-day diary at screening. Individuals with conditions that

required medical supervision of diet or exercise and those who participated in a weight-loss program in the six months prior to recruitment were excluded.

The study randomized 210 individuals to using either a standard PR, a PDA with dietary and exercise software, or a PDA with the same software plus a customized feedback program (PDA+FB). Since no differences were found in adherence to self-monitoring and the changes in dietary intake between the two PDA groups (PDA and PDA+FB) at six months, the two PDA groups were combined and analyses compared the changes in dietary intake between the two groups: PR users and PDA users (PDA and PDA+FB groups).

All three treatment groups received the same standard behavioral intervention; the only difference was in the method of self-monitoring assigned to each group. The cognitive-behavioral intervention included 20 group sessions during the first 6 months. All participants were instructed to self-monitor diet daily over the study period and were trained in using their self-monitoring tool during the first two weeks of intervention. The PR group was instructed to record all the foods consumed with the corresponding number of energy and fat grams. They also calculated subtotals periodically throughout the day to compare intake values to their daily goals. They were provided with a reference booklet and were taught how to find information when food labels were unavailable. Participants in the PDA groups were provided with PDAs with dietary self-monitoring software (Dietmate Pro©) that tracked and provided values for energy, total fat grams, percent calories from saturated fat, carbohydrate, protein and fiber intake. The PDA also provided subtotals in relation to daily goals automatically after each dietary entry.

At each session, PR participants turned in their diaries and the PDA participants turned in

their PDAs. The PDAs were downloaded to the study database; the interventionists received printed reports that looked similar to the PR for their review. At the next session, all participants received written feedback and prescribed daily energy intake based on gender and baseline weight. Additionally, each participant was asked to maintain a fat intake goal of 25% of the total daily calories. The intervention emphasized restricting calories and replacing total fat intake, especially saturated fatty acids, with increased intake of fruit, vegetables and whole grain products.

At baseline and six months, dietary intake was measured in all groups with two unannounced 24-hour dietary recalls (weekday and weekend day). Food group serving counts were used in the analysis. Adherence to self- monitoring was measured on a weekly basis and analyzed. If the weekly record indicated that a participant consumed more than 50% of the weekly calorie goal, the participant was defined as adherent to self-monitoring for that week. For example, a participant with a daily calorie goal of 1200 (weekly goal = 8400 kcal) would be adherent to self-monitoring if the person recorded consuming $\geq$ 4200 calories for that week.

Of 210 participants at baseline, 192 (91%) completed the six-month assessment. The parent study sample was predominantly female (84%) and white (78%) with a mean body mass index of 34.0 $\pm$ 4.5 kg/m^2. At six months, both groups had significant reductions in energy ($P<0.001$) and % calories from total fat ($P<0.001$) and saturated fat ($P<0.001$) which was paralleled by significant weight loss ($P<0.001$) compared to baseline, with no differences between the groups. However, compared to the PR group, the PDA group significantly increased servings of fruit ($P=0.02$), and vegetables ($P=0.04$) consumed and decreased their servings of refined grains ($P=0.02$).

The authors concluded that the PDA might provide some advantage over the use of PR when it is used for self-monitoring dietary intake. Participants in the PDA group increased their intake of fruit, vegetables, and whole grains and decreased their intake of refined grains more so than the PR group. They also stated the PDA might be a beneficial tool in helping individuals increase awareness of their eating behaviors and in the promotion of healthy behaviors.

Some limitations of the study were the inability to generalize these findings beyond the predominantly well-educated, full-time employed, white females who made up the majority of the group. Additionally, the findings of improvement in overall diet quality in the PDA group compared to the PR group could be explained partly by the advantages of using a PDA. Participants who used the PDA no longer had to look up foods in a booklet or complete calculations to determine the nutrient content of food consumed. Thus, the nutrient database in the PDA may reduce the recording time and moreover, the automatically provided nutrient content may improve adherence to self- monitoring and to dietary goals. Given that the PDA is portable and socially acceptable, individuals can record in any environment, which may reduce the uneasiness of self- monitoring dietary intake in public places. However, a PDA also has disadvantages. Compared to the traditional paper record, it can take some individuals longer to learn how to use a PDA.

Using daily self-monitoring of body weight, step count, fruit/ vegetable intake, and water consumption, Akers et al. (2012) evaluated the feasibility and effectiveness of a weight loss maintenance (WTLM) intervention for older adults. It was hypothesized that self-monitoring of increased water intake, body weight, step count, and fruit/vegetable consumption (WEV+) would be more effective at maintaining body weight than self-

monitoring of weight, step count, and fruit/vegetable intake (WEV) alone.

Participants were invited to participate in a 12-month single-blinded WTLM intervention (June 2007–February 2010) following completion of a 12-week randomized controlled weight loss (WL) intervention trial (July 2006–July 2008). The WL participants were overweight and obese adults aged 55–75 years who were recruited through local newspaper advertisements. To be included in the WL study, individuals were required to be weight stable (± 2kg, > one year). Participants in the WL intervention trial were randomly assigned to one of two groups: 1) intervention group (1200–1500 kcal hypocaloric diet + 16 fluid ounces water prior to each daily main meal) or 2) control group (1200–1500 kcal hypocaloric diet alone). The WL intervention did not include self-regulation, or self-monitoring strategies.

For the WTLM intervention, participants continued in their assigned treatment group (increased water consumption, "WEV+"; versus no increased water consumption, "WEV"). During the "WEV Changed" program, participants were instructed to record their body weight (W), daily physical activity (E) assessed by pedometer step count, and fruit/vegetable intake (FV) using self- monitoring tracking sheets. In addition, WEV+ participants were instructed to record daily water consumption.

All participants were given program goals as follows: more than10,000 steps per day, more than five fruit and vegetable servings per day, remain at or below baseline "reduced" body weight (within 3 lbs.), and consume at least 16 fluid ounces water three times per day (≥ 48 fl. oz.) prior to each main meal (WEV+ only). Participants were instructed to return tracking sheets weekly to the study coordinator for the duration of the 12-month study. Monthly laboratory-based assessments included body weight, four-day

food intake records, resting blood pressure, and an individualized counseling session with a registered dietitian (RD). Counseling sessions varied with each participant and were based on the participant's personal need each month (e.g., holiday eating, eating while traveling, and physical activity routines).

To assess habitual dietary intake, participants were instructed in proper methods to record four-day food intake records by the RD. Records were kept for three consecutive weekdays and one weekend day. Two-dimensional food diagrams were provided to assist participants in portion size determination. To assess habitual beverage consumption, baseline, months six and 12 food intake records were manually reviewed to determine mean daily amounts (kcal, g) of water and other beverages consumed.

Of the 40 individuals (aged 62.7 ± 0.9 years) enrolled, 39 individuals (95% Caucasian and 55% female) completed the 12-month intervention. There was a group baseline difference in previous weight loss (−7.7 ± 1.0kg WEV+ versus −5.7 ± 0.6kg WEV), but no significant group differences in height, body weight, BMI, and waist circumference. 80% of participants were successful in maintaining 3% weight regain and participants in both groups lost weight over time. WEV+ reported a higher mean yearly step count and fruit/vegetable intake. Overall compliance with returning tracking sheets was 76±5%, with no group difference.

The authors concluded that their findings were consistent with intervention trials reporting that self-monitoring of body weight and physical activity, and increasing fruit and vegetable consumption are effective long-term weight loss and maintenance strategies. Taken together, these findings suggest that practitioners could recommend daily self-monitoring of increased water consumption, along with body weight, step

count, and fruit/vegetable consumption, as a feasible and effective WTLM approach.

The weaknesses of this study were the small sample size and the primarily Caucasian middle-aged population who were recruited through advertisements. Additionally, the study did not have any sort of control group and was targeted at people looking to lose weight.

As shown from the two studies, monitoring fruit and vegetable intake through the use of self-monitoring tools can be effective in achieving healthier habits. Additionally, both studies monitored fruit and vegetable intake along with other behaviors. This suggests that studies that simplifying the monitoring to only focus on fruit and vegetable intake could be an effective method for changing behaviors long term and increasing fruit and vegetable intake.

Summary and Conclusions

This review of the relevant literature suggests that statistically significant increases in fruit and vegetable intake can be generated when behavior-based interventions are employed. However, the increases in fruit and vegetable intake were small compared to that necessary to achieve recommended intake levels. The research showed that multiple approaches, such as garden based activities and increasing access to fruit and vegetables, can be modestly effective especially when coupled with the use of technology such as computers and telephones. Additionally, self-monitoring devices also seem to have a greater effect than other methods on fruit and vegetable consumption and other healthful behaviors. Only with multidimensional approaches that include all ages and at the level of the family can we expect to achieve substantial improvements in fruit and vegetable intake. Achieving and sustaining fruit and vegetable intake at currently

recommended levels across the population will require stronger interventions, coupled with approaches including efforts to address taste, convenience, availability and access, competitive foods, and value perceptions. New and novel approaches are needed for behavior-based interventions to promote significant increases in fruit and vegetable consumption in both children and adults, since current approaches have only been modestly successful. Future research should focus on approaches that include all ages in promoting fruit and vegetable intake.

CHAPTER 3: METHODS

The purpose of this study was to evaluate the effectiveness of a daily monitoring tool to promote fruit and vegetable intake in families. A tool (Appendix A) was designed to be a checklist that could be posted on the families' refrigerators to monitor daily intake of fruit and vegetable consumption. The tool asked families to set a fruit and vegetable intake goal using recommendations from the United States Department of Agriculture for each individual. Individual intake goals are then added together to create a family goal. In addition to creating a family intake goal, the tool asked if families ate together as a unit, offered or served fruits and vegetables at each meal of the day, and ate fruits and vegetables at each meal. These questions were designed to assist family members in identifying what meals were most difficult to consume fruits and vegetables as well as generate discussion about food at the dinner table.

Subjects

Recruitment

Families were recruited through informational brochures (Appendix B) distributed at Sherman Park Lutheran School and Concordia University School-Pilgrim in Milwaukee, Wisconsin between May 15, 2013 and June 3, 2013. Amanda Giffin and Joanie Kolton, Health Services Coordinator of the LUMIN School District, distributed the brochures after school when parents were picking up their children. Ms. Giffin and Mrs. Kolton briefly explained the study and its requirements to the parents. These requirements included answering all questionnaires, participating in a one-hour education class on June 3, 2013, and utilizing a tool to track their daily fruit and vegetable intake for the three-month study period. Interested families completed the brochure and were

provided the Institutional Review Board (IRB) consent form (Appendix C) to read, sign, and return at the initial meeting with Ms. Giffin on Monday, June 3, 2013. Families were called and reminded to attend by Mrs. Kolton prior to the initial meeting.

Inclusion and Exclusion Criteria

Families who lived in Milwaukee, Wisconsin and had at least one child between ages of four to 17 living in their home were included in the study. Families with any children less than four years of age or with no children were excluded from the study. Families who could not complete all of the surveys were also excluded. Families also needed to speak English and signed the informed consent form to participate. Families had to participate in the one hour education session on June 3rd, 2013.

Study Protocol

On Monday, June 3rd, six families met with the researchers at Sherman Park Lutheran School. When families arrived, they filled out all necessary forms (see information about the forms in data collection). Water and an assortment of fruits and vegetables were provided as snacks. Children were given fruit and vegetable coloring pages (Appendix D) with markers and crayons. Ms. Giffin then led the one-hour lesson plan (Appendix E) to teach families how to determine estimated fruit and vegetable needs (Appendix F). The egroup participated in a discussion to determine how to increase fruit and vegetable intake and incorporate them into family meals and daily habits. Ms. Giffin explained how to use the fruit and vegetable refrigerator tool as well as how to use a separate checklist (Appendix G) to monitor the frequency in which they used the tool. On this separate checklist, participants were asked to record each day they used the tool and

whether or not they met their family fruit and vegetable intake goal. Ms. Giffin then explained how the data would be collected at the end of the study.

Data Collection

At the initial meeting (baseline), basic demographic data, family information, health history, eating behaviors and nutrition education history was collected using a questionnaire (Appendix H). Additionally, parents completed a Fruit and Vegetable Inventory (Appendix I) that measured their perceptions of fruit and vegetables and their readiness to change current habits at baseline. Parents filled out two additional surveys that assessed their personal fruit and vegetable intake (Appendix J) as well as their children's intake (Appendix K). These surveys were adapted from surveys provided by Dr. Marilyn Townsend of the University of California – Davis which had been researched and evaluated for effectiveness in two previous studies (Townsend, M.S. & Kaiser, L.L., 2005 & Townsend, M.S. & Kaiser, L.L., 2007).

At the end of the study, participants were mailed the same Fruit and Vegetable Inventory (Appendix I) and the same fruit and vegetable intake questionnaires (Appendices J & K). The participants were asked to mail these questionnaires along with the checklist (Appendix G) back to the researcher.

The researcher called each participant once during the course of the study to remind the participants to send in the completed data and to inquire about the use of the monitoring tool.

Data Analysis

Data was analyzed using basic mean and standard deviation measures in Microsoft Excel.

CHAPTER 4: RESULTS

Demographics

One member from each family completed the surveys on behalf of the entire family and is referred to as the main participant. Of the six main participants, all six (100%) were female and had a mean age of 43.67 =/-11.29 (Table 1). The participants also were predominantly Black/African American (66.7%), married/living with partner (50%), employed full-time (66.7%), and had two children (50%). All participants had at least some college education. Additionally, the majority of the participants (83%) had participated in previous nutrition education and one participant had to avoid fruits and vegetables due to an intolerance (Table 2). Of the six families that participated in the education portion of the study, two families (33.3%) completed the entire study.

Table 1: Demographic Data

Characteristic	Total
Age (years)	mean =/- SD
Main Participant (n=6)	43.67 +/- 11.29
Partner (n=3)	47.33 =/- 12.36
Children (n=12)	8.25 +/- 4.26
Gender	number (%)
Female	6 (100%)
Racial Background	
American Indian	1 (16.7)
Hispanic/Latino	1 (16.7)
White	3 (50)
Black/African American	4 (67.7)
Relationship & Living Status	
Single living alone	2 (33.3)
Married living with partner	3 (50)
Divorced	1 (16.7)
Income	
< $25,000	3 (50)
$50,000 – $74,999	2 (33.3)
$75,000 – $99,999	1 (16.7)
Education	
Some college, but did not finish	2 (33.3)
Two-year college degree / A.A / A.S.	2 (33.3)
Some graduate work	1 (16.7)

Completed Masters or professional degree	1 (16.7)
Employment	
Employed Full Time	4 (66.7)
Employed Part Time	2 (33.3)
Household Statistics	
Buys the food	5 (83.3)
Prepares the food	5 (83.3)
Number of Children	
1	2 (33.3)
2	3 (50)
4	1 (16.7)

Table 2: Nutrition History Data

Characteristic	**Total** (n=6)
Diabetes	number (%)
Type 2 DM	1 (16.7)
None	5 (83.3)
Avoid Fruits/Vegetables	
Yes	1 (16.7)
No	5 (83.3)
Food Allergies/Intolerances	
Yes	2 (33.3)
No	4 (66.7)
Previous Nutrition Education	
Yes	5 (83.3)
No	1 (16.7)

Fruit and Vegetable Perceptions

At baseline, families were asked about their perceptions towards fruits and vegetables using the "Fruit and Vegetable Inventory" (Appendix I). Most had positive perceptions towards fruits and vegetables at baseline (Table 3). As for their perceptions on their fruit and vegetable intake, none of the families rated their family's intake of fruits and vegetables as "Excellent," but 50% of the participants rated it as "Very Good," 33% as "Good" and only one family (16.7%) rated their fruit and vegetable intake as "Fair."

In regards to their stage of change at baseline, a majority (67%) of the participants indicated that their family was currently trying to eat more fruits and vegetables (data not shown). One family also indicated they were already eating three or more servings of

fruit per day at baseline through the "Fruit and Vegetable Inventory" (Appendix I), although that data was not confirmed by the adult in the "Fruit and Vegetable Checklist for Adults" (Appendix J).

Table 3: Fruit and Vegetable Perceptions Inventory

Question	Most Common Response	Total (n=6)
I feel that I am helping my family be eating more fruits and vegetables.	Agree	6 (100)
We may develop health problems if we do not eat fruits and vegetables.	Agree	5 (83.3)
I feel that our family can…		
…eat fruit or vegetables as snacks.	Agree	6 (100)
…buy more vegetables next time we shop.	Agree	5 (83.3)
…plan meals or snacks with more fruit during the next week.	Agree	6 (100)
…eat two or more servings of vegetables at dinner.	Agree	6 (100)
…plan meals with more vegetables during the next week.	Agree	5 (100)
…add extra vegetables to casseroles and stews.	Agree	6 (100)
How would you describe your family's diet?	Very Good	3 (50)

Fruit and Vegetable Intake

The average intake of the families at baseline was similar to national averages. Only two of the participants (33.3%) consumed the recommended amount of two or more servings of fruit per day (compared to an estimated 32.5% of adults nationally (CDC, 2010). However, none of the families consumed the recommended amount of three or more servings of vegetables per day (compared to 26.3% nationally). The children followed the same pattern as adults. Two of the families (33.3%) reported their children consuming two cups of fruit or more per day, and none of the families reported their children consuming three cups of vegetables or more per day. However, fruit and vegetable recommendations for children vary based on age and sex (see Attachment C) so it is uncertain whether or not each child is meeting their own guidelines. Additionally, the participants estimated intake of their children as a whole rather than calculating an amount for each individual child. The responses to each question from the "Fruit and

Vegetable Checklist" for children (Appendix K) and adults (Appendix J) are detailed in Figure 1.

At baseline, the average fruit intake (Table 4) of the children reported by the main participants was 1.5 cups per day (SD=0.76) and the average vegetable intake was 1.17 cups per day (SD=0.69). For the main participants, the average fruit intake reported was 1.42 cups per day (SD=0.45) and the average vegetable intake was 1.33 cups per day (SD=0.37).

Only two (33.3%) of the families completed the entire study and filled out all of the questionnaires again at the end. For these two families, average baseline intake was of fruit was 1.5 cups per day for the children and 1.75 cups per day for the main participants (Table 5). The average baseline intake of vegetables was 0.75 cups per day for the children and 1.25 cups per day for the main participants. At the end of the study, both the children and the main participants maintained the same average fruit intake of 1.5 cups (SD=0.71) for the children and 1.75 cups (SD=0.35) for the adults; however, both the children and the adults had an increase in average vegetable intake by 0.5 cups per day to post study totals of 1.25 cups (SD=0.35) and 1.75 cups (SD=0.35), respectively, following the three month intervention (Table 5).

Table 4: Fruit and Vegetable Intake Averages

Characteristic	**Baseline (n=6)**
Fruit Intake	mean cups per day (+/- SD)
Children	1.5 (0.76)
Main Participant	1.42 (0.45)
Vegetables	
Children	1.17 (0.69)
Main Participant	1.33 (0.37)

Table 5: Fruit and Vegetable Intake (Completers Only)

Characteristic	Baseline (n=2)	Post (n=2)	Difference
Fruit Intake	mean cups per day (+/- SD)	mean cups per day (+/- SD)	mean cups per day
Children	1.5 (0.71)	1.5 (0.71)	0
Main Participant	1.75 (0.35)	1.75 (0.35)	0
Vegetables			
Children	0.75 (0.35)	1.25 (0.35)	+0.5
Main Participant	1.25 (0.35)	1.75 (0.35)	+0.5

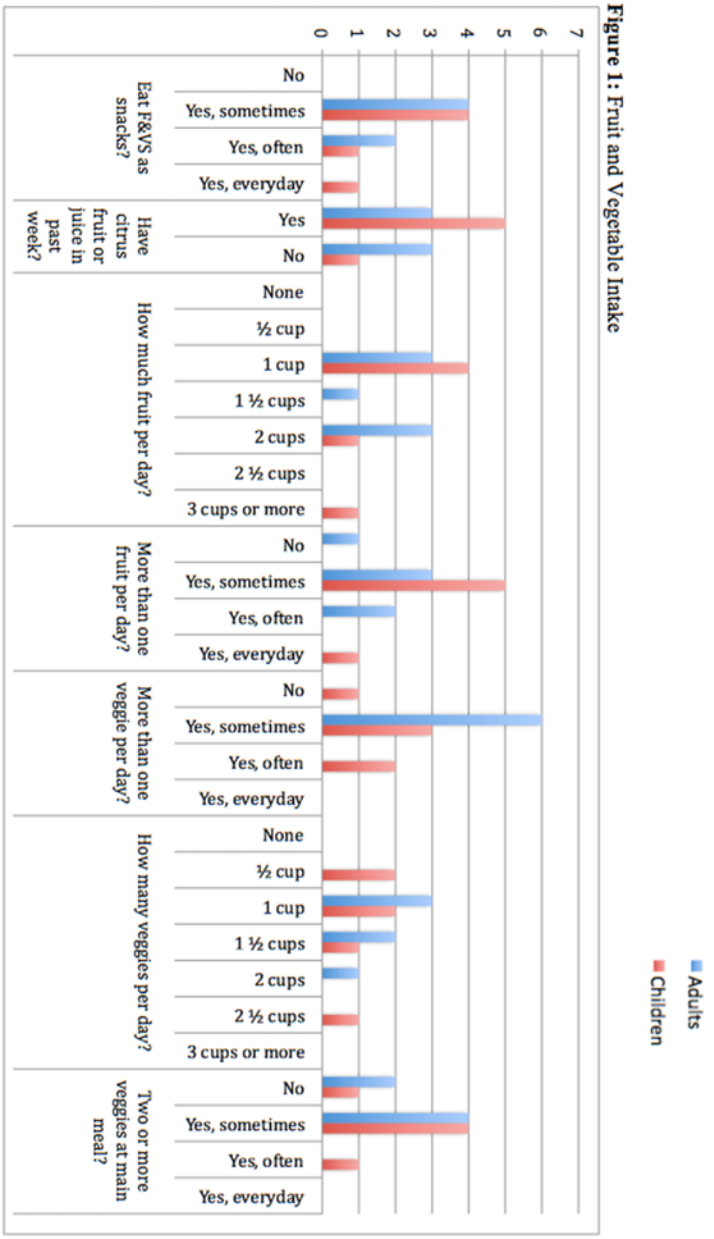

Figure 1: Fruit and Vegetable Intake

Use of Monitoring Tool

Only two of the families (33.3%) returned the entire packet with the post-intervention assessment information at the completion of the study. The first family used the checklist 42 out of 114 days (36%) and met their family fruit goal 60 out of 114 days (52.6%) and met their family vegetable goal 60 out of 114 days (52.6%) (Table 6). On the days when they used the checklist, the daily goal was met 100% of the time. The second family used the checklist 29 days out of 114 days (25.4%). They met their family fruit goal 27 days out of 114 days (23.7%) and met their family vegetable goal 20 days out of 114 days (17.5%).

Table 6: Monitoring Tool Use

	Family One	Family Two	Average
Used Tool	36.8%	25.4%	**31.1%**
Met Family Fruit Goal	52.6%	23.7%	**38.2%**
Met Family Veggie Goal	52.6%	17.5%	**35.1%**

Qualitative Feedback from Participants

At the end of the study, families were called to remind them to return in the forms. One of the six families could not be reached due to the provided phone number no longer working. Three of the families were successfully contacted: Family One and Family Two (from above), and Family Three (who did not return the post-questionnaires as of this time). Family One's main participant verbally reported that she was successfully able to use the checklist for the first month after the education session. Her family then went on vacation and "forgot about it for a while". In August before school started they got used to using it again but by the time school started again they had stopped. She still recorded that they met their fruit and vegetable goal even when not

using the checklist though because she had been buying more fruits and vegetables to ensure her family was eating more of them.

In Family Two, the main participant verbally report that her family used the checklist for about a month after the study began. She was able to get into a routine. She started using a measuring cup to measure out portions of fruits and vegetables into baggies for her and her children's lunch. Then she said after a while she didn't need to use the measuring cups because she was able to estimate better. She did find that it was much easier to incorporate more fruits than veggies, especially with her kids. She tried incorporating veggies into more dishes rather than having them on the side. She mentioned making spaghetti sauce with extra veggies and putting them into soups and stews.

In Family Three, the main participant verbally stated that the tool was helpful but when "life got hectic" she was unable to keep it up as much. Over the phone, she stated that she used it 90% of the time, and she and the rest of her family were never sick throughout the entire summer which was unusual for their family. "For a while, almost every month one of my kids or I was sick and then we weren't." To the participant, this was important as she felt the increased fruit and vegetable consumption helped to improve her family's health. She did mention that it would have been helpful to get some recipes or ideas provided with the tool so that when she ran out of ideas there could be something to reference.

Overall, the families found that the checklist tool was useful and that it helped them to realize that fruits and vegetables were missing in their diets. From their feedback,

the difficulty appeared to be getting the family together every day to go over the checklist, and avoiding skipping it when distractions occurred.

CHAPTER 5: DISCUSSION AND CONCLUSIONS

Fruit and vegetable intake has been associated with a decreased BMI and a reduced risk of the leading causes of death in the United States (Hung et al., 2004; Ledoux et al., 2011; Murphy et al., 2012). In the face of the obesity epidemic, and the rise of preventable chronic diseases, encouraging the public to eat healthfully and to increase their intake of fruit and vegetables is of paramount importance. The goal of this study was to increase fruit and vegetable intake in families to inform future research and public health interventions because small changes made by individuals can have a huge impact at the population level.

The current study achieved significant changes in vegetable consumption in both the children and their parents over time. Given that parental fruit and vegetable intake is a significant predictor of adolescent fruit and vegetable intake (Pearson, Biddle, & Gorely, 2008), it may be that parents who alter their fruit and vegetable intake are likely to be better role models and may modify the home environment to make fruit and vegetables more available and accessible to their children. Targeting parents to change their own behaviors may be an effective way of increasing both adolescent and parent fruit and vegetable consumption.

This study is the first known attempt to develop and test a monitoring tool for increasing fruit and vegetable intake in families. This research not only demonstrated the feasibility of using such a tool, but also confirmed that most families, despite previous nutrition education, continued to consume less than recommended amounts of fruits and vegetables.

Both parents and children appeared to particularly like, and make use of the monitoring charts that were provided. Self-monitoring is a systematic observation, and recording of target behaviors and previous research has identified this technique as the cornerstone of behavioral treatment (Weber Cullen et al. 1998, Klem et al. 1997)

Strengths of the study included a delivery channel that minimized the participant's burden, by? targeting of parents and children together. Additional strengths included the diverse mix of families recruited (despite only being six families) and the tailored nature of the initial meeting. The study also had a positive impact on increasing vegetable intake in the families, although fruit intake went unchanged.

The results of the present study are encouraging, but there are a number of shortcomings. The limitations of this study include the nature of the questionnaires. All of the measures were self-reported and parents also reported on behalf of their children. Self-reported fruit and vegetable intake can be unreliable, although in our questionnaire there were pictures of actual portion sizes to help subjects make a reliable estimate of intake. Additional limitations include the small sample size, lack of a control group, and small percentage of families that completed the study (33.3%). Other potential limitations include the short duration of the intervention.

Given that positive effects were seen in the present short intervention study, it is possible that the intervention effect might be sustained for substantially longer if the intervention period was extended, and additional materials such as recipes and education were provided to families.

Though this small study had many limitations, it showed that fruit and vegetable intake in both children and adults in this population was below recommended amounts. In

addition, the results from the two families that completed the study showed that the family-monitoring tool may have a positive effect on increasing vegetable intake. It also provides the tools necessary to implement the study with a larger audience.

Based on the comments provided by the participants, future interventions to increase fruit and vegetable intake should provide a guide with ways to incorporate more fruits and vegetables into foods along with recipes and pictures. Clearly, more research of this checklist tool is needed and would help to determine if this family monitoring tool is useful in increasing fruit and vegetable intake and maintaining the behavior change long-term. Family-based, self-monitoring interventions promoting fruit and vegetable consumption may be feasible and effective in increasing fruit and vegetable consumption. Future research is needed to examine the feasibility, efficacy and dose of such an intervention with a larger and more diverse sample.

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