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Rainbow diet : a new nutrition education tool

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RAINBOW DIET: A NEW NUTRITION EDUCATION TOOL

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Maribel Cedillo

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To: Dean Ronald M. Berkman
College of Health and Urban Affairs

This thesis, written by Maribel Cedillo, and entitled Rainbow Diet: A New Nutrition Education Tool, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this thesis and recommend that it be approved.

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DEDICATION

I dedicate this thesis to my husband Diego for always believing in my ideas. Without his support, patience, understanding, and most of all love, the completion of this work would not have been possible.

I also want to dedicate this thesis to my parents for teaching me to pursue my dreams.

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ABSTRACT OF THE THESIS

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The purpose of this study was to develop a developmentally appropriate new nutrition education tool, the Rainbow Diet for Children (RDFC), to encourage and aid parents in feeding their children according to current national recommendations. In phase I of the study, the RDFC was developed. Foods were grouped based on color. This grouping provided 11 food groups and foods that provide adequate nutrition for children ages 3-6 years. Using a focus group theoretical diets/foods selections in the RDFC were tested for nutrition adequacy.

Phase II of the study consisted of actual testing of the RDFC with children. Nutrition intervention was given to children at two Montessori Schools in Miami, FL. The RDFC and the Food Guide Pyramid (FGP) were used as nutrition education tools with different groups of children. Children and their parents were encouraged to follow one of the food guides for two weeks. Fifteen healthy children followed the food guides (9 children followed the RDFC and 6 the FGP) while 7 children served as control subjects. Pre and post nutrition analyses were conducted for all three groups.

A pre and post intervention comparison revealed three significant differences. For the FGP group cholesterol intake was significantly ($p<0.006$) increased and thiamin

intake was significantly ($p<0.022$) decreased. For the control group there was a significant increase ($p<0.005$) in the vitamin A intake.

For the inter group mean change scores (posttest-pretest) two significant differences were found. First, cholesterol intake in the RDFC was significantly ($p<0.045$) decreased while for the other two groups it increased significantly. Furthermore, the mean monounsaturated fat intake for the RDFC group significantly decreased ($p<0.047$) from pre to post, whereas in the other two groups it was increased. These findings support our hypothesis that it is possible to create an alternative meal planning system for 3 to 6 year old children. The RDFC group had adequate nutritional intake while following the rainbow diet meal plan.

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INTRODUCTION

The focus of childhood nutrition has expanded from preventing nutritional deficiency diseases to also avoiding nutrient over consumption and reducing the risk of future health problems. This new nutritional approach has been a response to the dramatic increase in the incidence of overweight and obesity among youths in United States.

Overweight and obesity in children are reaching epidemic proportions with an estimated prevalence of 25% among children and adolescents in the United States (Knehans, 2002; Micic, 2001; Morgan, Tanofsky-Kraff, Wilfley, & Yanovski, 2002; Yanovski, 2001). Obesity is defined as BMI in the 95th percentile or higher for age and gender, whereas overweight is defined as BMI in the 85th percentile or higher (Barlow & Dietz, 1998; Morgan et al., 2002; Troiano, Flegal, Kuczmarski, Campbell, & Johnson, 1995). According to the Center for Disease Control (CDC) and Prevention (1997), the prevalence of overweight and obesity in children and adolescents as defined by Body Mass Index (BMI) in the 95th percentile or higher for age and gender groups (Troiano et al., 1995) has more than doubled since 1976.

Recent data indicates that 10% of children ages 2 to 5 and 15% of children ages 6 to 19 are overweight (Flegal, Carroll, Ogden, & Johnson, 2002). Experts expect an increase in overweight and obesity among children throughout the 21st century.

Obesity in childhood is associated with many immediate consequences, including orthopedic, neurologic, pulmonary, gastroenterologic, endocrinologic, metabolic, and cardiovascular disorders (Dietz, 1998; Yanovski, 2001). Long-term consequences of pediatric obesity include risks for cardiovascular disease and death, independent of adult

body weight (Kiess et al., 2001; Must, Jacques, Dallal, Bajema, & Dietz, 1992; Yanovski, 2001). Thus, morbidity and mortality in the adult population are increased in individuals who were overweight in adolescence, even if they have lost the extra weight during adulthood (Deckelbaum & Williams, 2001).

Overweight has been found to continue through adulthood (Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). Overweight in adults dramatically increases morbidity and mortality rates from all causes and from specific diseases such as coronary heart diseases, stroke and colorectal cancer (Must et al., 1992).

In addition to the health problems linked to overweight and obesity, children who are overweight suffer from psychological, social and economical consequences (Gortmaker, Must, Perrin, Sobol, & Dietz, 1993; Wadden & Stunkard, 1987). Obese children are under considerable psychological stress as peer group discrimination is very common. Overweight classmates are seen as undesirable playmates and are often excluded from games and frequently teased (Staffieri, 1967). Overweight children as young as five years old have been found to associate their obesity with lowered self-body esteem and lower perceived cognitive development. As overweight adolescents, they may develop distorted body image, which puts them at risk for eating disorders. Furthermore, studies have shown that being overweight during adolescence and young adulthood weakens the chance of being accepted into high-ranking colleges (Canning & Mayer, 1967) and reduces job applicant's attractiveness to prospective employers (Roe & Eickwort, 1976; Yanovski, 2001). The direct relationship between overweight and social and economic consequences is not clear. However, when overweight was compared to

other chronic physical conditions, it was found that only overweight correlated directly with lower socioeconomic levels (Gortmaker et al., 1993; Yanovski, 2001).

The recent increases in the prevalence of obesity and the co-morbidities and psychosocial problems associated with obesity emphasize the need to develop effective prevention and treatment methodologies. Currently, the mainstay of prevention and therapy for overweight and obesity in children is diet and exercise. Research suggests that most pediatric obesity interventions are marked by small changes in relative weight or adiposity and substantial relapse. Nevertheless, some school-based nutrition education interventions have shown evidence for long-term efficacy. Studies have found that effective nutrition education protocols were developmentally appropriate, employed social learning strategies, and focused on eating behavior change rather than knowledge acquisition (Contento et al., 1995; Lytle, 1995).

An effective protocol involves a methodology that both parents and children can easily grasp. This may reduce time-to-teach concepts, consequently relieving some reimbursement issues. It can even improve commitment from care providers, as duties are simpler and more effective. The purpose of this study was to develop and test a new methodology to promote healthy eating habits, with children ages 3-6. We used the application of Cognitive Development Theory (CDT) and SCT in the design of a protocol for healthy eating based on color, a concept that young children know and understand well.

The Rainbow Diet for Children (RDFC), a nutrition education tool based on colors, was designed to deliver four important nutrition concepts (variety, portion, caloric intake and adequate milk intake). This tool was designed not only to provide the

acquisition of knowledge, but more importantly, a change in eating behavior. This methodology was also designed to be easy to adopt, model and be reinforced by parents.

LITERATURE REVIEW

The Problem of Childhood Obesity

Overweight and obesity are increasingly prevalent nutritional disorders among children and adolescents in the United States. Overall, it is estimated that as many as 25% of children may be obese (Rosenbaum & Leibel, 1988). This alarming statistic suggests that obesity has assumed a near-epidemic proportion, particularly among school-age children (Dietz, Bandini, & Gortmaker, 1990). Not only has the percentage of overweight children doubled in the past two decades, the prevalence of overweight has also increased (Kuczmarski, Flegal, Campbell, & Johnson, 1994; Troiano et al., 1995). It is estimated that 10-20% of obese infants will remain overweight throughout life (Merritt, 1982). It has also been observed that about 40% of overweight children will continue be overweight as adolesents and 75% to 80% of the obese adolescents will become obese adults (Deckelbaum & Williams, 2001). Overall, more than one third of overweight children will eventually become obese adults (Deckelbaum & Williams, 2001; Stark, Atkins, Wolff, & Douglas, 1981; Yanovski, 2001).

Overweight and obesity are not only an American health problem but they are also present in every continent, especially in the established market economies including Europe, Latin America, the Caribbean and the Middle East. Most distressing are the predictions that highlight a dramatic increase for this nutritional disorder. The Body Mass Index (BMI), which associates body weight with health related problems in adults, is expected to almost double in most developed nations by the year 2030 (Kopelman, 2000).

For children, statistics currently indicate dramatic increases in the prevalence of obesity in France, the Netherlands, United Kingdom and the United States. Data from 79

developing countries and a number of industrialized nations suggests that 22 million children under five years of age are overweight (>+ 2 standard deviations above NCHS reference median weight for height) (Daher, 1998). It has been suggested that these alarming statistics are the result of a greater socio-economic status of the market economies (Seidell, 1999). In the future, the prevalence of childhood obesity may resemble the current rise in adult obesity. Regretfully, the medical and psychosocial consequences of this disorder may be more severe in children as the duration of obesity is prolonged, and the rate of morbidity and mortality is higher.

Many children are at high risk of becoming overweight between the ages of three and ten years. It has been observed that the risk of becoming an obese adult is 3 to10 times greater if the child's weight is greater than the 95th percentile for his/her age. Having been born to an obese parent imposed a greater risk of overweight and obesity. There is a 75% chance that children, ages three to ten, will be overweight if both parents were obese. This drops to a 25-50% chance with just one obese parent.

The causes of obesity are complex and multifactorial. This chronic condition results from the interplay between environment and genetics (Segal & Sanchez, 2001). A tendency to be overweight may run in the family. Some children may be physically inactive. Some children may have unhealthy eating patterns. Experts believe that in most cases, overweight and obesity are the result of the combination of these factors. Medical conditions such as hormone imbalances account for only a few cases of childhood obesity (Rosenbaum, Leibel, & Hirsch, 1997).

Overweight and obesity in children are characterized by excess weight-for-length or weight-for-height. It is believed that the extra weight indicates excessive energy intake

or low energy expenditure, or both. Obesity results when caloric intake exceeds expenditure (unbalanced energy equation). It is not clear how the interplay between genetics and the environment result in obesity. The real impact of all factors involved among preschool-aged children has not been determined and is still under investigation. However, it has been determined that balancing the energy equation results in healthier weights.

Obesity in Preschoolers

The need for intervention programs that target childhood obesity are obvious as the rise in childhood obesity is well documented. Goals for healthy weight and weight reduction in children were included in Healthy People 2010. The report Healthy People 2010 outlines a national strategy for significantly improving the health of Americans by 2010 (US Department of Health and Human Services, 2000). The goal is to reduce the prevalence of overweight and obesity to <5% for children, 6 to 11 years old (base line 11%) and adolescents, 12 to 19 years old (baseline 10%).

Preschool children (age 3 to 6years) should also be targeted. Ten percent of children ages 2 to 5 and 15% of children 6 to 19 are overweight. Interventions must prevent these rates from further increases. Additionally, as eating habits are formed at an early age, targeting preschool children could translate into future decreases in childhood and adult obesity rates. That is, if interventions are effective and result in life-long learning, childhood obesity may be halted and adult obesity may be prevented in many cases.

Behavioral and metabolic factors during childhood support early treatment of obesity. For example, children in comparison to adults have a shorter history of habits that lead to positive energy and thus may be more responsive to intervention. In addition, given the typical family environment, children have the potential for greater support of behavior change than most parents. Furthermore, the mechanism for changes in terms of weight is also thought to be different. Adults show changes in their overweight status only by weight reduction. These weight reductions have been associated with a decrease in metabolic rate, which is believed to impede further weight loss. Children, if growing appropriately, will gain weight and lean body mass as they develop. Therefore, they can show an increase in metabolic rate while decreasing their percentage overweight (Epstein et al., 1989). It has been suggested that children maintain weight loss easier than adults (Epstein, Valoski, Wing, & McCurley, 1990).

Dietz (1999) pointed out four significant barriers that currently limit obesity treatment. These include the time available for counseling families, lack of effective protocols, reimbursement and the commitment of primary care providers to care for the affected patients (Dietz & Nelson, 1999). The need for a simple methodology and protocols for the promotion of healthy habits (eating and exercise) and treatment of childhood obesity that can overcome these limitations are clearly indicated.

Nutrition Recommendations for Children

National Recommendations

There are several recommendations regarding food choices that promote health and prevent disease. The Dietary Guidelines for Americans is the nutrition policy endorsed by the U.S. Department of Health and Human Services (Peterkin, 1990). It provides advice to Americans about eating a varied diet of grain products; vegetables and fruits; low fat milk products or other calcium-rich foods; beans, lean meat, poultry, fish or other protein-rich foods. The guidelines also encourage participation in vigorous physical activity. Guidelines recommend that children ages of 2 to 5 years gradually reduce their fat intake so that by age 5, they are consuming no more than 30% of calories from fat (Peterkin, 1990). The Dietary Guidelines for Americans advices that any diet change should be accompanied by growth monitoring.

Fat reduction in diets (≤30% of total calories from fat and 10% of total calories from saturated fat) for children 2 years and older is included in the 2010 Healthy People Report. The National Cholesterol Education Program also recommends that total fat intake average no more than 30 % of calories for children and adults (Cleeman & Lenfant, 1998).

Other organizations provide advice and nutritional recommendations for children. The American Academy of Pediatrics recommends that children eat a wide variety of foods and enough calories for normal growth and body weight. The Academy also recommends an intake of 30 % of total calories from fat, less than 10 % of calories from saturated fat, and less than 300 mg of cholesterol per day for children older than 2 years

old. However, the Academy of Pediatrics ("American Academy of Pediatrics, Committee on Nutrition, Cholesterol in childhood," 1998) cautions recommendations that call for less than 30 % of calories from fat may lead to the inappropriate use of more restrictive diets."

The American Heart Association (AHA) concurs with the recommendation of the Dietary Guidelines about fat reduction. The AHA also agrees with the Dietary Guidelines' recommendation that diets of young children should maintain adequate calories and nutrients for normal physical activity, growth, and development (Lauber & Sheard, 2001).

Some groups however, disagree about the age at which children should reduce their fat intake. The Canadian Pediatric Society recommended a longer transition period to reduce fat intake. Their transition period ranges from infancy to cessation of linear growth (age 14 for females and 15 for males). During infancy, the diet should provide about 50 % of calories from fat and decrease to provide only 30 % of calories as fat and 10 % of calories as saturated fat when reaching linear growth. These groups suggest that there is no evidence that can sustain health benefits from early fat reduction (Albertson, Tobelmann, Engstrom, & Asp, 1992). Others, express their concern that some children consuming low fat diets may have lower energy intakes and low intakes of some nutrients (Albertson et al., 1992).

Food Guide Pyramid for Children

The Food Guide Pyramid (FGP) and the Dietary Guidelines for Americans were developed with the aim of teaching the American public to eat in a healthier fashion. The FGP is the primary nutrition education tool designed to help healthy Americans select a diet consistent with the Dietary Guidelines. The FGP illustrates patterns of food selection that provide adequate amounts of food energy, protein, vitamins, minerals, and dietary fiber for good health and moderate amounts of fat, added sugars, and sodium. The base of the pyramid consists of the grain group (refined carbohydrates such as breads, cereals, rice and pasta). Vegetables and fruits are divided into two groups on the next level. The groups were divided because the pyramid designers felt that fruits would be chosen over vegetables since fruits have a preferred taste. In the middle of the pyramid are the meat and milk groups and within the apex are the fats, oils and sweets groups.

To help improve the diets of young children 2 to 6 years old, the USDA developed the Food Guide Pyramid for Young Children. This Pyramid is an adaptation of the original Food Guide Pyramid simplifying the educational messages and focusing on young children's food preferences and nutritional requirements (Center for Nutrition and Policy Promotion [CNPP], 1999). The CNPP staff determined that the nutrients in the foods children consume, if eaten in amounts recommended by the original Food Guide Pyramid, would meet children's nutrient needs. They concluded that because Pyramid food groups and recommended numbers of servings resulted in a nutritionally adequate diet for young children, the Pyramid graphic could be adapted for young children. The graphic shows foods that are commonly eaten by young children, drawn in a realistic style, and shown in single serving sizes when possible. The food group names have been

shortened to simplify them, and the number of servings recommended is a single number rather than a range (CNNP, 1999).

With the goal of providing guidance for children in a way that motivates behavior change in both adults and children (Contento et al., 1995), the CNPP also conducted qualitative research to determine parents' wants and needs (Tarone, 1999). The research consisted of focus groups with open-ended, structured discussions and interviews with small groups. Even though, focus group research results are not projectable to any population, they provided insight into how the consumer views the world and what the consumer thinks (Dietz & Gortmaker, 1985). As reported by Tarone (1999) important findings from this focus group research about what parents and caregivers want and need to improve diets of young children included:

- Parents/caregivers want directions. They want to know what to do; they want to use the Food Guide Pyramid; they want easy-to-read materials.
- Parents/caregivers want activities that involve children; and more information on food variety.
- Parents and caregivers want a more "child-friendly" graphic of the Food Guide Pyramid to use with young children.
- Three prototypes are needed: a parent piece, a caregiver piece, and a "child-friendly" graphic of the Food Guide Pyramid, all based on one theme: "Choose a variety of foods for a healthful way of eating."

Finally, all messages should be simple, positive, behavior-oriented, and developmentally appropriate for young children.

Current Dietary Food Intakes for Children

Data on children's food consumption are provided by several national surveys: Department of Health and Human Service's National Health and Nutrition Examination Survey (NHANES III), USDA's Continuing Survey of Food Intakes by Individuals (CSFII), and the Market Research Corporation of America (MRCA) (Albertson et al., 1992; Kennedy & Powell, 1997). National Health and Nutrition Examination Survey results reported a median energy intake below 100 % of the Recommended Dietary Allowance (RDA) for several age-gender groups ("Daily dietary fat and total food-energy intakes--Third National Health and Nutrition Examination Survey, Phase 1, 1988-91," 1994). The CSFII 1994-96 reported low energy intake in half of the children ages 5 years and younger. The CSFII 1994-96 reported that about 20 % of the children had energy intakes below 75 % of the RDA (Ballew, Kuester, Serdula, Bowman, & Dietz, 2000).

Several studies have reported that preschool-age children have energy expenditures lower than the RDA (Davies, Gregory, & White, 1995; Fontvieille, Harper, Ferraro, Spraul, & Ravussin, 1993; Goran, Carpenter, & Poehlman, 1993). According to CSFII 1994-96, only about 5 to 10 % of all children have energy intakes at or above 150 % of the RDA (Ballew et al., 2000). However, increasing prevalence of overweight among children might reflect children underreporting the foods eaten (Ballew et al., 2000).

Food consumption surveys report that, on average, two-thirds of all children are consuming more than 30 % of calories from total fat and more than 10 % of calories from saturated fat (Albertson et al., 1992; Kennedy & Powell, 1997). In the Framingham

Children's Study, it was assessed that children consumed an average of 33 % of calories from fat (Oliveria et al., 1992).

Children 5 years and younger met the "age + 5" dietary fiber intake recommendation of the American Health Foundation (mean fiber intakes 11g/day). However, children ages 6-11 didn't meet the fiber recommendation (mean fiber intakes 14 g and 12 g respectively).

These national surveys report that most American children get adequate amounts of vitamins and minerals, except for vitamin E, vitamin A, zinc, iron and calcium. Vitamin E and zinc are consumed at levels below 100 % of the RDA by most children 2 to 19 years old (Alaimo et al., 1994). According to CSFII 1994-96, 40 % of children 5 years and younger, and 40 % of females 6 to 11 years old consumed iron below 100 % of the RDA. These studies also show that only one-third of adolescents 12 to 19 years old consumed 100 % or more of the RDA for vitamin A (Alaimo et al., 1994).

Another nutrient that children consume at levels below the recommendation is calcium. In 1994-96, only half of the children 11 years old and younger consumed 100 % or more of the 1989 RDA for calcium. Less than 30 % of all children ages 9 years and older met the new Adequate Intake (AI) for calcium (1,300 mg) (Alaimo et al., 1994; Saltos, 1999). For children 12 to 19 years old, average calcium consumption is below the 1989 RDA of 800-mg. Only 33 % of males 12 to 19 years old and about 15 % of females of the same age consumed 100 % or more of the calcium for 1989 RDA (Alaimo et al., 1994).

CSFII 1994-96 data showed that children's intake of fruits and vegetables was low. Only 25 % of children 2 to11 years old consumed the minimal recommended

servings of vegetables (3 per day) according to the Pyramid. Only about 40 % of females and 55 % of males 12 to 19 years old met the minimal recommended number of servings. For fruits, about half of all 2 to 5 year olds consumed the minimal recommended servings (2 per day). However, as age increased fruit consumption decreased among 25% of all children 11 to 19 years old (Saltos, 1999). Krebs-Smith et al. (1996) examined 3-day data from CSFII 1989-91 for children and adolescents 2 to 18 years old. Even after foods were separated into their component ingredients (e.g., credit was given for vegetables in mixed dishes, such as on pizza or in sandwiches), only one in five children consumed the recommended five servings of fruits and vegetables per day. One-quarter of all vegetables that were consumed were french fries. Children from families with higher income levels consumed more servings of fruits and vegetables, as compared with children from families with lower income levels (Krebs-Smith et al., 1996). Low intakes from the fruit and vegetable groups could explain some of the low nutrient intakes, particularly for vitamins A, C and folate.

Sodium intakes for many children are found higher than the upper limit listed on the Nutrition Facts label (2,400 mg per day). According to NHANES data, children 6 years and older had median sodium intakes greater than 2,400 mg a day (Alaimo et al., 1994). The CSFII 1994-96 reported that sodium intake from food also exceeded 2,400 mg per day for all children 3 years and older. Mean sodium consumption for males ages 12 to 19 years was 4,407 mg per day.

Healthy Eating Index

In an effort to measure how well American diets conform to recommended healthy eating patterns, the Healthy Eating Index (HEI) (Kennedy, Ohls, Carlson, & Fleming, 1995) was developed by the USDA Center for Nutrition Policy and Promotion . It provides a single summary measure of diet quality using the most current scientific information available, including the Dietary Guidelines for Americans (USDA, 2000) published by USDA and DHHS and the Food Guide Pyramid. The HEI incorporates nutrient needs and dietary guidelines into one measure.

The higher the score on the HEI, the better the diet conforms to the Dietary Guidelines for Americans and the Food Guide Pyramid (Kennedy et al., 1995). The Index has been found to correlate positively with other conventional measures of diet quality such as the RDA (Kennedy et al., 1995). Kennedy et al. (1995) found that people with higher HEI scores were more likely to have better nutrient intake. Higher HEI scores (total possible score of 100) have been associated with individual nutrient intakes greater than 75% of RDAs (Kennedy et al., 1995).

The HEI consists of ten components, each representing a different aspect of a healthful diet. Components 1 to 5 measure the degree to which a person's diet conforms to the FGP meeting recommendations for the five major food groups: grains, vegetables, fruits, milk products, and meat/meat alternates. Components 6 and 7 measure fat and saturated fat consumption according to the Dietary Guidelines. Components 8 and 9 measure cholesterol and sodium intake. Finally, Component 10 measures the degree of variety in a person's diet. For each 10 components, a score of 0-10 is assigned. The Healthy Eating Index score is the sum of these 10 components scores. The range of HEI

is 0-100. An HEI score above 80 implies a "good" diet, a score between 51 and 80 implies a diet that "needs improvement" and a score less than 51 implies a "poor" diet.

For components 1-5 (Food Guide Pyramid Food Groups) individuals who consume the recommended number of servings receive a maximum score of 10. A score of zero is assigned for any food group where no food items from that group are eaten. Scores between zero and 10 are assigned based on the number of servings consumed. For example, if the recommended number of servings is 8 and an individual consume 4 servings, the component score for the individual is 5 points (one-half of 10).

For components 6 and 7 (fat and saturated fat respectively) scores are related to their consumption in proportion to total energy consumed. Fat intakes less than or equal to 30 percent of the total calories are given a score of 10. The score declines to zero when the proportion of total calories from fat is 45 percent or more. Linear interpolation is used to calculate fat intake scores when fat contributes between 30 to 45 percent of total calories. Intakes of saturated fat are similarly scored. A score of 10 is given to an intake of less than 10 percent of total calories from saturated fat and a score of zero for intakes that contribute 15 percent or more of the total calories.

Components 8 and 9 (cholesterol and sodium respectively) are based on the milligrams consumed in the diet. A score of 10 is given for cholesterol intake less than or equal to 300 milligrams per day. Zero points are given for intakes of 450 milligrams or more. For sodium, a maximum score is obtained for intakes less than or equal to 2400 milligrams per day. A zero score is given for sodium intakes of 4800 milligrams or higher. For both components, intermediate scores for intakes between the two cutoff points are assigned proportionately.

Finally, for component 10 (variety) different foods eaten in amounts sufficient to contribute at least one-half of a serving in a particular food group is counted as a "different food item". A maximum score of 10 is awarded if 16 or more different food items are consumed over a 3-day period. A score of zero is given if 6 or fewer food items are consumed. Intermediates scores are awarded proportionate to consumption between the cutoffs. For food mixtures, component ingredients are assigned to relevant food groups. Similar types of foods are grouped together and counted only once in measuring the score for variety. In computing the variety component for the 1-day periods, the number of foods needed to receive the maximum score is reduced by a factor of two, from 16 foods to 8 foods (Kennedy et al., 1995).

The HEI nutrient intake scores use the DRI category for nutrient intake analysis. Dietary Reference Intakes values are used for calcium, phosphorus, magnesium, thiamin, riboflavin, niacin, folate, vitamin B6, vitamin B12, vitamin A, vitamin C, vitamin E, iron, zinc and selenium. For all nutrients except calcium, the RDA is used for a particular gender/age category; for calcium, the Adequate Intake (AI) value is used. The HEI uses the 1989 Recommended Energy Allowance (REA) for food energy.

Treatment for Childhood Obesity

Current Modalities

The main goal of therapy should be to achieve the objective of a lifelong healthy weight. Therefore, it is important to know the child's pattern of growth and weight gain. In general, any therapeutic approach for childhood obesity should be designed to induce decreased energy intake and increased energy expenditure while maintaining normal growth. Intervention to induce weight loss must consider all of the factors that are believed to cause obesity and treatment modalities that have been shown to be effective.

Diet

The role of dietary intake in obesity remains controversial. Obese adults often claim that they do not ingest excess food (Schoeller, 1990). These patients often seek medical evaluation for failure to lose weight despite a history of severe caloric restriction. A number of studies have demonstrated that obese adults tend to under report food intake compared to normal weight subjects. However, the problem is often confounded in the clinical setting by the difficulties in assessing food intake and food efficiency.

Only some obese individuals are sensitive to dietary restrictions. It has been found that there are no differences in resting energy expenditure between diet sensitive and diet resistant obese individuals. However, there are differences in lean body mass that account for the variations in weight reduction induced by dietary intake restrictions in obese individuals. Patients who gain lean body mass increase their metabolic rate, whereas those who are on diets and are losing lean body mass may reduce energy expenditure by 10-20%. Thus the results of dietary efforts can only be successful if the reduced intakes

are accompanied by increased energy expenditures to overcome the metabolic adaptation that occurs with dieting.

The high susceptibility to obesity may also be the result of unlimited availability of palatable and high-calorie-density foods. Laboratory adult rats fed a "supermarket diet" consisting of high carbohydrate/high fat foods (i.e., chocolate chip cookies, marshmallows, peanut butter, etc.) gained two and a half times more weight than normal controls (Sclafani & Springer, 1976). In some animals, the weight gain was not reversed after the rat was switched back to chow. It is believed that supermarket diets increase the number and size of fat cells in rats.

Dietary composition and different rates of nutrient utilization of ingested diets may also influence body weight maintenance. Using an indirect calorimetric technique in non-obese males, Flatt et al (1985) demonstrated that under sedentary conditions, ingested carbohydrates are quickly metabolized while the rate of fat oxidation remains unchanged (Flatt, Ravussin, Acheson, & Jequier, 1985). Moreover, it has been suggested that the body tightly regulates carbohydrate balance for up to 36 hours after ingestion and is not affected by alteration in the body's fat balance (Schutz, Flatt, & Jequier, 1989). On the other hand, fat balance is believed to be regulated over a long-term and it may take several days before the fat balance adjusts to new levels of fat ingestion. Thus, it is believed that excessive fat consumption over a long period of time will result in a positive fat balance and weight gain (Golay & Bobbioni, 1997; Rolls & Shide, 1992). Currently, a number of medical organizations, including the American Heart Association (AHA, 1996) and the American Diabetes Association (ADA, 2000), recommend consumption of low-fat diets to prevent and treat of obesity. However, the relationship

between dietary fat and obesity has recently been questioned (Allred, 1995; Katan, Grundy, & Willett, 1997; Larson et al., 1996) since both cross-sectional and longitudinal analyses have failed to show a consistent association between dietary fat and body weight (Kant, Graubard, Schatzkin, & Ballard-Barbash, 1995; Nicklas, 1995). Furthermore, some studies indicate that weight loss on low-fat diets is usually modest and transient (Katan et al., 1997; Lissner & Heitmann, 1995). Additionally, it is noteworthy that the rate of obesity has continued to rise in the United States despite reported reduction in mean fat intake over the past 30 years, from 42% to 34% of dietary calories in the United States (Allred, 1995; Nicklas, 1995).

Glycemic index

The glycemic index (GI) is another dietary factor that may influence body weight. Glycemic index is a property of carbohydrate-containing foods that describes the rise in blood glucose after a meal (Wolever, Jenkins, Jenkins, & Josse, 1991). The average American diet contains starchy foods that are primarily refined grain products, cereals and potatoes and have a high GI. In contrast, vegetables, legumes and fruits have generally a low GI (Foster-Powell & Miller, 1995). It has been suggested that a potential adverse consequence of the decrease observed in mean fat intake in recent years is a concomitant increase in high GI foods (Nicklas, 1995; Stephen, Sieber, Gerster, & Morgan, 1995). Since fat slows gastric emptying (Welch, Bruce, Hill, & Read, 1987), carbohydrate absorption from low-fat meals may be accelerated. Recently, it has been found that using a low-glycemic index as treatment for childhood obesity resulted in

greater weight loss than a standard reduced-fat diet (Spieth et al., 2000). Long term effects and safety of this diet need to be evaluated in children.

Traffic-light Diet®

The Traffic-light Diet® is another approach that may be suitable for preschool and preadolescent children (Epstein, Valoski, & McCurley, 1993). This diet was used to decrease caloric intake and promote a balanced diet. The Traffic-light Diet® used a color-coded, calorie-based food exchange system. Foods were divided into 11 food groups, with foods within each group color-coded according to caloric density per average serving. The food groups were divided into three categories: green foods (go) can be consumed in unlimited amounts; yellow foods (caution) have average nutritional values within each group; and red foods (stop) provide less nutrient density per calorie because of high fat or simple carbohydrate content (Epstein, Valoski, Koeske, & Wing, 1986; Epstein et al., 1990). Green foods were less than 20 calories per average serving; yellow foods were any foods yielding no more than 20 calories per average serving above the standard for its group; and red foods were any foods yielding more than 20 calories above the standard for its group. All sweets and sugared beverages were classified as red foods. Participants were given a 1200-1500 calorie limit and a sample diet with menus. They were taught how to keep a diet diary and to chart daily weights, caloric intake, number of red foods eaten and amount and type of physical activity. The diet rules included keeping calorie intake under calorie limits and eating no more than four red foods per week. Families were strongly urged to remove all red foods from their homes. Evaluation of the relationship between habit change and weight loss during intensive

treatment showed a strong relationship between decrease in red food intake and weight loss (Epstein et al., 1990). To promote a balanced diet, families were encouraged to eat daily minimums of two servings of high protein foods, two servings of dairy foods, four servings of grains and four servings of fruits and vegetables. Parents and children used a picture chart to record intake on this basic diet and gave their children stars on those days a balanced diet was consumed. Checking picture record sheets and diet diaries were used to monitor adherence to dietary changes. This diet was found to be successful in reducing obesity and changing eating habits in preadolescent children (Epstein et al., 1990; Epstein, Valoski, Kalarchian, & McCurley, 1995; Epstein, Wing, Steranchak, Dickson, & Michelson, 1980). Furthermore, weight loss was maintained up to ten years when the Traffic-light Diet® was combined with behavioral, exercise and familial components of a comprehensive treatment program (Epstein et al., 1990).

Very Low Calorie Diets and Low Carbohydrate Diets

The National Task Force on the Prevention and Treatment of Obesity published a report on the efficacy of very low calorie diets on weight reduction ("Very low-calorie diets. National Task Force on the Prevention and Treatment of Obesity, National Institutes of Health," 1993). Although rapid weight loss could be achieved, the long-term evolution of obese patients on these diets proved to be disappointing. Slowly they regained their pre-treatment weight, regardless of the prescribed diet given.

There are few studies documenting the success of structured programs for treating childhood obesity that encompass just the use of very low calorie diets. Caloric restriction to a very low level using a protein sparing, modified fast (PSMF) diet (400-800 kcal/day)

is designed to produce rapid weight loss of up to five pounds (2.3kg) per week, while preserving vital lean body mass. The protein is provided as lean meat or fish, or in a milk- or egg-based liquid formula. It has been suggested that these diets spare body protein by decreasing insulin levels and enhancing fat breakdown (Flatt & Blackburn, 1974), while inhibiting the release of amino acids from muscle (Sherwin, Hendler, & Felig, 1975). However, in the past, several deaths have been associated with the use of these formulas (Samanin & Garattini, 1989). Moreover, these quick-fix weight loss schemes may be unsafe for use in children and do not promote healthy eating behaviors for long lasting weight control.

Nutritionally balanced very low calorie diets, combined with exercise, may improve the outcomes in structured obesity treatment programs for children (Robinson, 1999; Sothern, Loftin, Suskind, Udall, & Blecker, 1999). In one study, obese adolescents entered a structured 10-week program that included exercise and behavior modification, along with a very low calorie diet. After ten weeks BMI decreased from 33.8 to 29.6. Furthermore, fat mass was reduced without decrements in either lean body mass or energy expenditure (Zerbe, 1987) . In another study by the same investigators, 87 obese children from 7-17 years old participated in a year-long program similar to one previously described. The results were the same and weight and body fat loss was maintained for one year. These results suggest that a multidisciplinary structured program to treat obese children yield positive results.

Low-carbohydrate diets are usually high in protein and fat. They involve intake of large amounts of meat and restrict carbohydrate-containing foods such as fruits, vegetables and grain products. The high intake of fat in such diets can increase the risk of

coronary heart disease and other problems like gallstones and high cholesterol. The body depends heavily on its fat stores for energy while on a low-carbohydrate diet. This can lead to ketosis. The rapid weight loss on these diets is attributed to high amounts of water loss (60 to 70% of weight loss was water) and the dieters often regain weight rapidly once normal eating is resumed (Andersen, Backer, Stokholm, & Quaade, 1984; Wadden & Stunkard, 1986). However, it is important to reemphasize that energy intake, not energy consumption or distribution of calories, determines weight loss (Golay et al., 2000). Therefore, a balanced diet that provides a reduced intake of calories is preferable as the approach helps children achieve long-term weight control with healthier eating behaviors.

Theoretical Framework for Nutrition Intervention

It is important to understand the theoretical models that have been used for nutrition intervention and nutrition education among children. All strategies aim to bring about changes in children's knowledge, attitudes toward food and improvement in eating behaviors. In the past two decades, two different nutrition education approaches have been used; one is knowledge based and the other is behavior oriented. Each approach used has different goals, content and outcomes.

Knowledge-Based Approach

This approach enhances children's overall nutrition knowledge. The goal is to increase knowledge, skills, and attitudes needed by children to understand food and nutrition issues and to make dietary choices that are good for their general health. That is,

children are expected to learn and apply learned information to modify their food choices and eating behaviors. Knowledge-based nutrition education is seen as part of general education and is designed to produce nutritionally literate consumers.

Many of these programs were sponsored by the USDA Nutrition Education and Training (NET) program and involved state curricula. Some were also funded by the food industry. The programs grew out of the field of nutrition science believing that knowledge acquisition would influence food practices. Almost all knowledge-based education programs, resulted in improvements in knowledge but showed inconsistent improvements in behavior (Auld, Romaniello, Jerianne, Hambidge, & Hambidge, 1998; Hochbaum, 1981).

Behavior-Intervention Approach

Behaviorally oriented programs emerged in the 1980s as a result of the increased evidence linking diet to chronic disease. The National Institutes of Health (NIH), particularly the National Heart, Lung and Blood Institute (NHLBI), funded these programs to reduce risk factors in children through school-based programs. This approach to nutrition education aims to reduce disease risk and enhance health. The educational outcomes are changes in specific behaviors, such as eating patterns that are lower in fat or sodium and higher in fiber, or acquisition of specific behavioral skills needed to modify targeted behaviors. These behaviorally oriented programs grew out of fields of health education, social psychology and the behavioral sciences.

Social Cognitive Theory (SCT) has been applied in successful behavior change programs (Bandura, 1977). This theory suggests that individual, behavioral and

environmental factors interrelate and are important in effecting behavior change. This approach highlights the importance of experiential learning, skill building, and goal setting in achieving behavior change (Lytle, 1995). It also gives special attention to cognitive processes in order to obtain behavior changes (Contento et al., 1995). Motivations and values are also considered part of these cognitive processes. This approach uses operant conditioning (reinforcement and punishment), as well as modeling (engaging in behavior that was observed) (Bandura, 1977, 1997; Price & Archbold, 1995).

Nutrition education programs for children using the behavior approach have been designed to address personal factors, behavioral factors and environmental factors. Personal factors include knowledge about health and value placed on health and self-efficacy (one's perception of one's ability to make a change or accomplish a task). Behavioral factors include the development of behavioral skills, intentions to act, existing behavioral repertoire, incentives, and reinforcement. Finally, environmental factors address parental influences and support, cultural norms and expectations, opportunities and barriers and peer and adult role models.

Moreover, according to behaviorists, children learn behaviors through experiencing the consequences of their behavior and through learning the reinforcement/punishment from others that result from their behaviors. This conditioning results in behavioral patterns that are continuously developed and shaped over the course of the child's life. Jeor et al. (2002) suggest that behavioral modeling is more important during the establishment of new behaviors, while operant conditioning is more relevant

during the maintenance and shaping of these new behaviors (St. Jeor, Perumean-Chaney, Sigman-Grant, Williams, & Foreyt, 2002).

Investigators agree that cognitive behavior therapy used in nutrition education has greater impact than the traditional knowledge based approach (Lytle, 1995; Lytle & Achterberg, 1995). The cognitive behavior approach provides a methodology for systematically enhancing healthy eating habits, exercise, or other behaviors that are thought to contribute to improving nutritional status (Stunkard, 1996). Cognitive behavioral strategies include self-monitoring, goal setting, stimulus control and modification of eating style and habits. Cognitive behavioral approaches include cognitive restructuring strategies that focus on challenging and modifying unrealistic or maladaptive thoughts or expectations, stress reduction/management strategies, and the use of social support (Foreyt & Goodrick, 1994; Perri & Fuller, 1995).

Lytle (1995) reviewed studies and found that effective nutrition interventions for adolescents had a behaviorist approach. This interventions incorporated instructional strategies based on appropriate theory, adequate dose (amount of education required to stimulate positive behavioral change), peer involvement, self-assessment and feedback, environmental interventions to complement behavioral lessons and community involvement.

Contento et al. (1995) recommended that programs be behaviorally based and appropriately designed for the child's age of cognitive development. They suggest that preschool and early elementary school age children (4 to 7 years old) need activities that allow them to modify their environment. They propose food-based activities and adults modeling eating behaviors. They consider parent and caregiver involvement crucial with

this age group. Furthermore, they consider older elementary school age children (8 through 11 years) still need to have information presented in concrete, easy to understand terms, parent modeling and involvement, interaction with the environment and activities.

There is insufficient data concerning weight management for children ages 3 to 5 years; most studies focus on children ages 6 years or older and findings may not be directly applicable to preschool children who are under more direct parental control. For example, one preschool study showed that parental control was the best predictor of a preschool child's ability to regulate energy intake (Johnson & Birch, 1994). They found that parental control inversely correlated to the ability of the child to self regulate energy intake. They concluded that the optimum situation for preschoolers' healthy eating was one in which parents provided healthy food choices, but allowed the children to assume control of how much they consumed. Furthermore, the Framingham Children's Study (Oliveria et al., 1992) showed that nutrient intake of preschool children (especially saturated fat, total fat and cholesterol) had a significant relationship with parents' eating patterns. This study focused on the influence of parents in the quality and quantity of food intake as well as the activity patterns of preschool children. Parents and caregivers have an important and lasting influence on the eating and physical activity habits of young children.

Cognitive Development Theory

It is important to understand that in identifying effective nutrition programs, these programs will only work if they are considered in relationship to the cognitive maturity of the children. Cognitive development is a major influence on what children can learn,

including what they can learn from nutrition education. Cognitive development and maturity develop with chronological age.

Piaget, the founder of Cognitive Development Theory (CDT), proposes that knowledge is not received passively by a child but is "constructed" actively through the process of thinking or reasoning about experience (Beilin, 1992). This theory suggests that children have fewer ideas than adults, and that these ideas are different in kind than those held by adults (Lovell & Ogilvie, 1960).

Cognitive development theory suggests that chronological age has a major influence on a child's ability to categorize, generalize and think causally. Piaget's classification of the thinking process consists of four periods or stages of cognitive development: sensorimotor, preoperational, concrete operational and formal operational. Each stage precedes the next, reconstructs it on a new level, and later exceed it to move to the next level.

The sensorimotor period (birth to 2 years of age) includes presymbolic and preverbal intelligence, which involves the development of action schemes. Inference begins when the infant develops relations among actions.

The preoperational period (2-7 years of age) includes the beginning of partially logical thought. Children are unable to realize that an object or principle remains the same even when it changes contexts (for example, water poured into another container is the same water). The attention of the child is centered on a limited visual aspect of a stimulus when it is presented. The thinking of a preoperational child is not reversible. The child cannot follow a line of reasoning back to its start. As a result, preoperational children are unable to "conserve" matter, number, area or volume. The child reasons from

the particular to another and decisions are made on the basis of perceptual cues. Children are able to function in the conceptual-symbolic mode. The use of language is a prime example of the use of symbols. Children at this stage tend to repeat words and sentences without comprehension because they do not yet have access to the basic cognitive structures for understanding them. Gradually, language develops and the socialization of behavior occurs. At this stage, children learn to manipulate symbols as in creative play which requires a cognitive level and understanding of symbols. Along with symbolization, there is a clear understanding of past and future.

The concrete operational period (7-14 years of age) includes the development of logical ways of thinking linked to concrete objects. The concrete operational child develops logical thought that enables him or her to "decenter" perceptions and understands transformations. Children begin to understand "conservation of substance." The child can now understand that these transformations are mental and reversible and understand the notion of "conservation." The child can also make classifications and generalizations, which means that he/she can mentally arrange items serially according to some property. The child begins to develop co-possibilities in problem-solving situations and ways to systematically exclude them.

During the formal operational period (older than 14 years of age) the child develops the capability of dealing logically with multifactor situations. Individuals can deduce multiple possibilities and systematically exclude them. Reasoning proceeds from the hypothetical situations to the concrete.

Food is quite complex cognitively with respect to attributes that a person may recognize and use in making food choices. However, for decades nutrition education has been using various food guides that intend to convert professional scientific knowledge of food composition and nutrient requirements for health into practical plans for food choices (Pennington, 1981). Food guides can be used with children because they provide specific instructions that are assumed to be understood by children (Contento, 1981; Michela & Contento, 1984). However, there is no record in the nutrition literature of scientifically designed studies to test the usability aspects of any food guide (Light & Cronin, 1981).Technically accurate food guides fail if they cannot be understood, remembered, and effectively used by their intended audiences (Light & Cronin, 1981).

The food guide approach is "cognitively formal" in nature. It requires the understanding of abstract concepts such as nutrients and requires the ability to classify. That is, foods such as beans and meat are placed into the same food group because of their high concentration of a non-observable, abstract nutrient called "protein." Children are not able to perceive how the nutrients can classify foods.

Furthermore, preoperational children cannot "conserve." That is, they cannot understand that food can be transformed and yet remain the same in essence. Moreover, they cannot carry out hierarchical classification; specifically, they cannot understand that "sugars" or "vitamins" are at the same time also "foods." Concrete operational children also would have difficulty understanding how unseen, abstract entities called "nutrients" can affect their bodies in observable ways.

Focusing on nutrients, the nutritional effects of foods, or even food grouping based on nutrients may seem to be an inappropriate basis for teaching children of this age about foods and nutrition (Lytle et al., 1997; Matheson, Spranger, & Saxe, 2002; Michela & Contento, 1984). Therefore, the information presented and the activities designed should take into account the cognitive stage difference in children. Children's limitations in understanding the effects of food and its components on the body should be taken into account when designing nutrition education programs. Piagetian theory suggests that no amount of teaching will make children learn concepts which are beyond the capacity of their cognitive structures to understand (Contento, 1981).

Cognitive Development And Food Classification

There is evidence that suggests that children may have difficulty understanding classification systems that place foods into groups largely on the basis of their nutrient composition (Anliker, Laus, Samonds, & Beal, 1990; Contento, 1981; Michela & Contento, 1984; Singleton, Achterberg, & Shannon, 1992). Children do not understand the abstract "nutrient concept" because they do not realize that food is processed by the human digestive system to extract the needed nutrients (Contento, 1981). Their concrete thoughts only allow them to see the actual foods. In one study among children 5 to 11 years of age, the youngest viewed foods as unchanged in the body. Older children viewed foods as undergoing some changes in physical form (e.g., to small particles). Only a few of the oldest children demonstrated an understanding that food brought about its effects on the body through components called nutrients. Contento (1981) also found that younger children particularly had difficulty understanding terms such as "sugar" and

"vitamins." Although they were familiar with the terms, children did not understand what they meant and did not realize they were food components.

It has been suggested that one likely reason for children's difficulty in understanding nutrient-based classification of foods is insufficient cognitive development (Michela & Contento, 1984). The act of classifying is a mental operation carried out on cognitive representations of objects and depends on the abstraction and retention of clear criteria. Children at lower levels of cognitive development are unable to make consistent use of criteria as abstract as nutrient composition. Research by Inhelder and Piaget (1964) indicates that in performing classifications of objects, pre-operational children use one of two kinds of sorting, resemblance or exhaustive (Inhelder & Piaget, 1964). In resemblance sorting, objects that resemble each other are placed together, but different bases may be used for different groups of objects. In consistent and exhaustive sorting, all objects are grouped together based on a single attribute that is based upon perception. Later children are able to include one class within a larger class of objects (additive or hierarchical classification) and to perform multiple membership classification (multiple classification) in which an object may be placed into more than one class simultaneously.

In a study by Michela and Contento (1984), children ages 5 to 11 were asked to classify foods in order to assess cognitive development in relation to nutrition. Results showed children (five to six years old) had a common tendency to group concrete concepts such as sweet versus non-sweet foods and meal entrees *versus* breakfast foods and drinks. Results also showed an increase in the number of bases of food classification with increasing cognitive development. Children classified according to perceptual, functional and physical properties of food. Only older children classified foods according

to food origin (animal or plant) or degree of processing. Older children also demonstrated a better understanding of the term "nutrient", however, conceptually, there was still poor understanding. The authors concluded the need to design health education curricula that are appropriate to students' cognitive developmental levels and to their naturally occurring conceptualizations.

In another study done with preschool children, Anliker et al.(1990) demonstrated that children could classify foods into the fruit group but not into the vegetable or milk groups. This article suggests that children do not fully understand the casual reasoning behind food classification but do have some ability to classify food (Anliker et al., 1990). Another study also supports this idea; 5-year old children were able to categorize foods as healthy or unhealthy (Singleton et al., 1992).

Recognizing what children are able to understand becomes very important when designing nutrition education methods. Young children will only learn what they are cognitively able to process. Children's understanding of abstract concepts and relationships such as food groups, nutrients, portion sizes, and servings proposed by the Children's Food Guide Pyramid becomes questionable. Perhaps it would be more practical to use naturally occurring conceptualizations as the basis for instruction about foods and nutrients, even when the goal is to foster messages that are more sophisticated.

Matheson et al (2002) recently determined criteria preschool children used to classify foods and their interpretation of their daily food experiences. This study is important as it reflects children's cognitive development in relation to nutrition understanding. Additionally it provides the foundation to redesign nutrition intervention for children (Matheson et al., 2002).

Matheson et al. (2002) found that food classification for preschoolers appeared to be primarily based on concrete, easily observed physical characteristics of food including color, shape or texture rather than more abstract criteria such as food groups. Children were given items such as two fruits, a vegetable, and meat to test whether they distinguished animal-based foods from plant-based foods. For each item the most frequently selected answer was the correct choice, however, the rationale given by the children did not indicate that they used traditional food groups to classify foods, rather, they used physical characteristics (Matheson et al., 2002).

The most commonly used rationale was color (used by 26 % of children). Other rationale used to classify foods included origin (animal or vegetable) and production methodology (cooked or raw). Food was also classified using the meal concept that described whether the foods were eaten at the same meal or if one food was considered a snack food.

Cognitive Development and Nutrition Messages

Complex material and abstract concepts used to send nutrition messages may result in misconceptualizing and non-adherence to guidelines. Children are not cognitively ready to understand the messages nor to use the information to make healthful choices. Concepts such as "lower fat," "lower sodium," or "high in Vitamin C" are abstract concepts since one cannot see them or even taste them. In order for individuals to follow the advice "Eat a diet low in fat," they must be able to determine the fat content of a food, determine some acceptable level, and then make dietary choices appropriate to the "low fat" message. Another example of abstract concepts used for food

guidelines is the Food Guide Pyramid (commonly used for children). In order to understand, remember and use the Food Guide Pyramid, one needs to understand and categorize the following abstract concepts: nutrients, food groups, serving sizes, serving portions (which depend on the type of food and cooking style), food origin and caloric content. All these nutrition messages are complex and abstract. Perhaps children are able to acquire nutrition knowledge from the guidelines but are not able to understand how to use this information and translate it into behavior.

Lytle et al (1997) investigated how kindergarten to sixth grade children understand and use nutrition messages proposed by the Dietary Guidelines for Americans (DGFA) and The Food Guide Pyramid. Lytle et al (1997) found that children in pre-operational or concrete operational stages had difficulty interpreting abstract concepts such as nutrients, as well as interpreting more abstract terms such as "variety" and "healthy weight." Only the older groups (5^{th} and 6^{th} graders) were able to verbalize a meaning for variety and healthy weight (Lytle et al., 1997).

Lytle et al (1997) also found that young children were unable to find a clear distinction between high fat foods and foods high in salt or sugar and had a tendency to inappropriately classify all snacks using these terms. Furthermore, children in this study were not able to distinguish cholesterol from fat and were not able to identify foods from the grain group (Lytle et al., 1997). However, children were able to identify fruits and vegetables. The author suggests that this knowledge about fruit and vegetables comes from the program “Eat five serving of fruits and vegetables a day” and not from the other two guidelines.

To evaluate children's ability to translate nutrition terms and messages into behavioral responses, Lytle et al (1997) evaluated children's responses to the questions regarding food labels, their understanding of servings from the FGP, and evaluated them using the Food Identification Task (FIT). This study found that none of the children were able to explain how the nutrient levels listed on the labels could be used to guide food decisions and offered unrealistic criteria for determining the acceptability of food, based on label information. The authors suggested that the abstract concepts used in food labeling such as "% daily value" has no meaning for children.

When assessing the use of the FGP, Lytle et al (1997) showed that children had difficulty operationalizing and determining the number of servings appropriate for them. They also found that when children where trying to explain the term "variety," they tried naming the food groups from the FGP but only one out of the 141 children did it correctly. These results suggest that even though children were exposed to the FGP, they were not able to remember it or use the information.

The authors concluded that it is not enough that children know the terms used in the food guidelines or that these foods are good for them, they must also know how to identify these foods and be able choose or ask for them. This research suggests that nutrition messages need to be developmentally appropriate and give specific behavioral messages in order to positively influence the eating choices of children.

Nutrition Intervention in School Programs

Many efforts have been directed towards educational programs and school policies to increase nutrition knowledge, improve dietary intake and prevent future

chronic diseases such as diabetes and obesity among children. The USDA's Nutrition Education and Training (NET) program provided many nutrition education school programs targeting young children. These programs were designed for inclusion in the school curricula from kindergarten through grade twelve; they also employed different educational theories. Researchers studied the programs after intervention and found increased nutrition knowledge in almost all programs and all school grades. However, they did not have a strong impact in behavior change. This supports the belief that acquiring nutrition information and concepts are not enough to change behavior. These results lead to questions regarding teaching strategy, delivery method, curricula, time spent or even measurement instrumentation.

For example, one nutrition education program "Nutrition in a Changing World" developed for kindergarten to grade 12 students, stressed the nutritional value of vegetables and whole-grains cereals. When a study was done to determine the effect of such programs researchers found a favorable effect in nutrition knowledge, however no dramatic influence on children's food behavior (Graves, Shannon, Sims, & Johnson, 1982).

A shorter duration nutrition education program (only nine weeks) for kindergarten through sixth grade had the objective to improve selection of school food items. Curricula emphasized the importance of eating a variety of foods, focusing on the nutritional value of vegetables and whole-grain cereals. This education program involved fun activities such as interactive cafeteria activities and word puzzles. The program evaluation revealed improved nutrition knowledge, however, except for kindergarten children, there was no significant evidence to suggest a change in food behavior (Graves et al., 1982).

Two recent studies examined the effectiveness of a nutrition education program called "Active Program Promotion Lifestyle Education in School", conducted in England (Sahota et al., 2001). This program was instituted in ten schools over a one-year period. Sahota et al. (2001) found a significant increase in knowledge and awareness about nutrition, however, there was no significant change in children's nutrition habits or behavior. Most school interventions described in the literature have reached similar conclusions (increased knowledge but slight or no behavior changes). Atkinson and Nitzke (2001) suggest that school-based prevention programs have limited potential for curbing the epidemic of obesity among children.

Intervention and prevention programs analyzed by Story (1999) showed positive, though short-term results in almost all the interventions. She mentions that few primary prevention research studies target obesity prevention programs (Story, 1999). Meininger (2000) reviewed studies involving minority students published in 1986-99 that sampled elementary, middle or high school students including a comparison group. This review study found no consistent effects of school-based intervention on body mass and obesity, blood pressure, or lipid profiles, although knowledge and health behaviors did change.

Ciliska et al. (2000) and Contento et al (1995) performed similar systematic reviews of the effectiveness of community based interventions to increase fruit and vegetable consumption. Ciliska et al. (2000) studied children ages 4 and older. These studies found that the most effective interventions were the ones that gave clear messages about increasing fruit and vegetable consumption (Ciliska et al., 2000). Successful programs included the following factors: reinforcement of nutritional messages, family

involvement, intensiveness, and long-term and theoretical framework base (Contento et al., 1995).

Contento (1995) found a successful educational program called "Know Your Body" (kindergarten to grade seven). This was a multi-component nutrition education program based on the social cognitive theory. The program was designed to teach 2,973 children that they were responsible for their health. Objectives included nutrition knowledge, exercise, substance-abuse prevention and emotional well-being. Games, simulations and role-plays were used as educational tools. After 2.5 years, students showed a decrease in total serum cholesterol and blood pressure. Health knowledge was improved and vegetable intake was increased.

Another successful nutrition education program developed for kindergarten to grade 12 students was called "Food...your Choice" (Contento et al., 1995). Each year children had 8-17 sessions of the educational program. The objectives of the program were to improve childrens' food choices, nutrition attitudes and knowledge. When the program was assessed, researchers found that knowledge had improved at all grade levels as well as positive attitude changes toward the consumption of fruits and vegetables. The research data collection instruments were 24-hour records, consumption frequency lists, and the nutrition knowledge attitude test. However, the real effect of the educational program in the childrens' health was not measured.

One of the largest interventions targeted at school age children was the Child and Adolescent Trial for Cardiovascular Health Study (CATCH), which randomized 4,019 children representing many ethnic groups from the United States (Perry et al., 1998). Third grade students received an extensive intervention (15-24 lessons with family and

food service activities). The post-test 24 hour records showed no differences between the intervention and control groups in total servings of fruits, vegetables, or fruits and vegetables combined and no significant differences in cardiovascular risk factors including obesity, blood pressure, and serum lipids. However, students who received intervention maintained a significantly lower fat diet and continued to pursue more vigorous physical activity levels two years after intervention when compared to the students in the control groups, although the difference between the two groups was waning. Researchers believed that over time no difference would be detectable. The CATCH study suggested that schools can be an important place to help youth establish healthy habits; however, additional research is needed to investigate modalities to maintain interventions beyond elementary school (Nader et al., 1999).

When school-based programs and school and family programs were compared, outcomes revealed only a small benefit in dietary knowledge. CATCH's investigators suggested that this could be the result of the low levels of parental participation. It is well documented that greater family involvement has a significant effect on short-term dietary improvement among children (Crockett, Mullis, & Perry, 1988).

Sahota et al's (2001) study and previous studies have reached the same conclusion. Most school-based intervention programs increase knowledge about nutrition, but they rarely produce significant changes in behavior or favorable short to intermediate term health outcomes (Sahota et al., 2001). Atkinson's (2001) analysis on school based programs concluded that given the limited benefits obtained from school-based programs, it would be more cost effective to target higher-risk children and devote

resources to more intensive treatment programs. Research is still needed to identify the most appropriate strategies to treat obesity in children (Atkinson & Nitzke, 2001).

<u>Using Color to Promote Health</u>

Given the poor compliance of children to dietary recommendations and the alarming overweight and obesity rates, the need to create an eating guide appropriate to students' cognitive developmental levels and to naturally occurring conceptualizations is crucial (Michela & Contento, 1984).

To create a successful eating guide, it is important to use messages and concepts that children are able to understand, retain, remember, use and incorporate in their play. Concepts need to be expressed using an attractive methodology that will captivate children's attention and interest.

Color is a concrete concept that children can conceptualize and understand. Even young infants discriminate and categorize colors well; color is a salient feature of a child's world, and children are aware of color as a separate domain, know color terms, and respond to color questions with color names (Bornstein, 1985). Furthermore, color is a physical property of food and it was found that children naturally tend to classify foods due to physical properties among perceptual and functional characteristics (Matheson et al., 2002; Michela & Contento, 1984). Moreover, it was color (the physical property) that children used the most to classify food (Matheson et al., 2002). A diet based on colors may promote an easy to learn eating pattern that children are be able to grasp and remember for life.

The concept of using color-coding to bring diversity to adult diets has been recently introduced (Heber & Bowerman, 2001). This color code is based on phytochemicals. Phytochemicals give color to fruits and vegetables and have been found to be key players in long-term health. The most known and significant functions of phytochemicals are : antioxidants, DNA protection and prevention of blindness, as well as prevention of cardiovascular diseases, cancer, dementia and premature aging. This color-coding classifies fruits and vegetables into the following seven groups (Heber & Bowerman, 2001):

1. RED: Tomatoes and tomato products such as pasta sauce, pink grapefruit, and watermelon contain lycopene
2. RED-PURPLE: Grapes, prunes, blueberries, blackberries, and strawberries contain anthocyanins.
3. ORANGE: Carrots, sweet potatoes, cantaloupe, pumpkin, mangoes, and winter squash contain beta-carotene.
4. ORANGE-YELLOW: Oranges, tangerines, peaches, pineapples and nectarines contain vitamin C.
5. YELLOW-GREEN: Spinach, kale, green and yellow peppers, green beans, yellow corn, and turnip, mustard, or collard greens contain lutein.
6. GREEN: Broccoli, brussels sprouts, and cabbage contain sulforaphane, isothiocyanate, and indoles.
7. WHITE-GREEN: Garlic, onions, chives, leeks, and shallots contain sulfur.

Recently several expert groups have recommended eating abundant fruits and vegetables in order to benefit from phytochemicals and reduce disease risk (Joseph, Denisova et al., 1998; Joseph, Shukitt-Hale et al., 1998; Meydani, 2002; Tucker, 2001; Youdim & Joseph, 2001). Research also suggests that a balanced diet, abundant in different nutrients and phytochemicals, may be an important key to healthy aging (Tucker, 2001). Moreover, recent research indicates that anthocyanins, which is what gives color to blueberries, helps fight age-related memory loss (Joseph, Denisova et al., 1998). Other research found that lutein, the yellow pigment in spinach could play an important role in vision protection (Joseph, Shukitt-Hale et al., 1998).

Abundant research has demonstrated the benefits of a diet with a high consumption of fruits and vegetables which leads to decreased risk of cancer (Steinmetz & Potter, 1991a, 1991b, 1996; Weisburger, 1991) and cardiovascular diseases (Gey, 1993; Hertog, Feskens, Hollman, Katan, & Kromhout, 1993). Beneficial health effects of increasing fruits and vegetables have been associated with the content of vitamins, minerals, dietary fiber and phytochemicals (Tomas-Berberan and Robins, 1997). Whether the health benefits of fruits and vegetables come from phytochemicals, vitamins, minerals, fiber or a combination of all these, it seems clear that eating a variety of fruits and vegetables and learning to eat them on a daily basis will translate to better health and disease prevention.

Up to now, no one has tried to use colors to classify food groups for young children. The purpose of this study was to create a guideline for healthy eating that introduces four important nutritional concepts (variety, serving size, adequate caloric

intake, and adequate calcium intake) to children using colors. The Rainbow Diet for Children (RDFC) classifies foods by their colors or close color.

Color-coding for children could facilitate the understanding, learning and practice of eating a balanced diet. The premises of this study include that *variety* in the diet and adequate amounts of foods are key to compliance to current recommended guidelines and health and that encouraging the use of a balanced diet may translate into better nutrition and health status in children.

Neither adults nor children should be expected to become nutrition scientists in order to be able to choose a healthful diet. Nutritional messages should be translated into information that is meaningful and useful to children and parents. Nutritional messages should be kept simple, positive and behaviorally oriented, while at the same time being scientifically correct and developmentally appropriate for children. Creating a diet based on color that complies with current Dietary Guidelines could be a potential tool that may translate nutritional messages into effective, simple, understandable, easy-to-learn and memorable concepts and modify behaviors to promote healthy eating.

Children are an excellent learning audience acquiring new knowledge, attitudes and behaviors. Adult food-choice behaviors have been traced to childhood (Contento et al., 1995). It has been found that by age nine, many children have already developed nutrition misconceptions that affect their lifelong eating patterns (Borra, Schwartz, Spain, & Natchipolsky, 1995). If important nutrition concepts are delivered effectively to children, they may achieve healthy eating patterns that can be sustained in adulthood. The opportunity to deliver clear, easy-to-follow information that will help them develop

healthy eating behaviors must be taken seriously as it may be the foundation of obesity prevention.

Innovative protocols to promote healthy eating habits in children must include a methodology that is designed for children, accounting for their developmental level (Contento, 1981). Protocols should also be viable, fun and should relate to them in order to promote and sustain significant life long learning (Buchin, 1992). Parents must also be involved and follow protocols to promote healthy eating, as it is crucial that children receive positive reinforcement from role models (Contento et al., 1995).

Providing children and their parents and caregivers with effective and age-appropriate tools for nutritional well-being and the prevention of obesity may prove invaluable in targeting and preventing other obesity health-related risk factors.

The purpose of this thesis is to support the hypothesis that it is possible to create an alternative meal planning system for 3 to 6 year old children based on pre-established food lists based on color.

The IRB approval was obtained from the Florida's International University Institutional Review Board committee (Appendix A).

METHODOLOGY

Due to the complex design of this study, we grouped experiments into two phases. Phase I of the study involved the development of the RDFC educational tool (experiment 1) and developing an experimental theoretical model (experiment 2) based on focus group studies.

Phase II of the study consisted of actual testing of the RDFC against FGP and control group. Table 1 illustrates the summary of experimental design and methodology used within each experiment.

The following sections will present each experiment the purpose, hypothesis, methods and materials and results of each experiment.

Table 1. Experimental design summary

Phase I		Phase II
Experiment 1: Develop RDFC Food Guide based on Color	Experiment 2: Focus Group Theoretical Model	Experiment 1: Testing of RDFC
1. Establish dietary goals for children 3-6 years of age in terms of energy, protein, fat, calcium and fiber requirements. 2. Determine foods with high nutritional value and enjoyed by children. 3. Group Foods by Color. 4. Determine Portion Size of Food. 5. Analyze the content of carbohydrate, protein, fat, calcium and fiber for each food item and by color group. 6. Edit portion sizes and food items depending on nutrient content to comply with dietary goals. 7. Determine the nutrient content (carbohydrate, protein, fat, calcium and fiber) of RDFC (Theoretical Model). 8. Review criteria for food group formation. 9. Establish a set of rules for RDFC use, which will assure compliance with the dietary goals.	■ Objective: Conduct a nutritional analysis using a theoretical week's diet based on the food choices of a focus group. ■ Subjects - Children age 3-6 - Parents - N= 7 ■ Outpatient Clinic MCH (waiting room) ■ Informal Interview - Determined favorite foods from each color group of RDFC. ■ Constructed 7 menus, one for each day of the week, randomly using foods most commonly chosen by children/parents. ■ Nutritional value was determined using the interactive HEI online software.	■ Objective: - Test the RDFC as an educational tool with children. - Compare RDFC and the FGP methodologies to a non-intervention group. ■ Subjects - Children age 3-6 - N=22 ■ Nutrition intervention: children/ parents at Alexander Montessori School. ■ Obtained a base-line food record prior to nutrition intervention. ■ Provided materials to follow diet. - RDFC - FGP ■ Agreed to follow diet for two weeks ■ Provided instructions and materials for a 2 day diet recall ■ Addressed any question throughout the week. ■ Conducted nutrition analysis. ■ Compared intra and inter group results.

Phase I

Experiment 1: Developing the RDFC instrument

Purpose

The purpose of this study was to develop a new nutrition education tool (Rainbow Diet for Children, RDFC) that would encourage and aid parents in feeding their children according to current national recommendations (DRI, American Dietary Guidelines and the American Academy of Pediatrics).

The following Hypothesis was tested:

Food groups based on the color of foods as well as carbohydrate, protein, fat, calcium and fiber content will provide adequate nutrition for children 3-6 years of age.

Methodology

During Phase I of the study, the Rainbow Diet for Children (RDFC) was developed. Foods were classified into groups using a color-coding system. A child friendly graphic icon was created to represent the food group distribution (Appendix B). For each color of the rainbow, a food list was developed and presented as an attractive poster (Appendix C).

In order to develop the Rainbow Diet for Children the following steps were followed:

1. Dietary goals for children 3-6 years of age were established in terms of energy, protein, fat, calcium and fiber requirements using national recommendations. These

nutrients were determined to be the backbone of the RDFC as complying with them would probably translate into adequate intakes of all other essential nutrients.

a. The Acceptable Macronutrient Distribution Ranges (AMDRs) were used to determine adequate amounts of carbohydrate, protein and fat as it has been shown that complying with the AMDRs will provide adequate intakes of essential nutrients (Trumbo, Schlicker, Yates, & Poos, 2002).
b. The Adequate Intakes (AIs) for calcium was established as a dietary goal for the RDFC. Significant amounts of calcium are provided by diary products, which often are white in color. Given that the RDFC was based on colors, it was important to assure compliance to the AIs of calcium (800 mg) while designing the RDFC.
c. The AI for fiber was also determined to be a dietary goal for the RDFC to assure that the amount of fiber in the RDFC would be adequate. It was important as it was suspected the RDFC would exceed the recommendations of fiber while promoting higher intakes of fruit and vegetables.

2. Foods were determined with high nutritional values that are also enjoyed by children.
3. Foods were grouped by color.
4. Food portion sizes were determined.
5. Carbohydrate, protein, fat, calcium and fiber content of each food item were analyzed (Appendix D) by color group.
6. Portion sizes and food items were edited depending on nutrient content to comply with dietary goals.

7. The nutrient contents (carbohydrate, protein, fat, calcium and fiber) of RDFC (Theoretical Model) were determined.
8. Criteria for food group formation was reviewed
9. A set of guidelines for RDFC use was established, which will enhance compliance with the dietary goals.

Results

The RDFC was designed to meet energy, carbohydrate, protein, fat, calcium and fiber needs for children 3-6 years of age. The Food and Nutrition Board of the Institute of Medicine as well as the American Academy of Pediatrics recommendations were revised in order to design a new food guide that complied with the most current nutrition recommendations for children 3-6 years old. For energy expenditure recommendations, scientific literature was reviewed to determine an adequate daily caloric intake.

In order to fulfill the nutrient requirements for children 3-6 years old we first determined the total caloric intake that could be provided by the RDFC. The energy requirement for children was based on Resting Energy Expenditure (REE) plus Activity Energy Expenditure (AEE). The REE for children 3-6 years old was calculated using the Schofield formula for healthy children assuming ideal heights and weights (Schofield, 1985). For this age group, REE recommendations are from 750-950 kcal/day for boys and 718-789 kcal/day for girls. The AEE of 400 kcal has been proposed adequate for children 3-6 years of age (Goran, 1997). The addition of both REE and AEE gave a kilocalorie requirement average of 1,352 for boys and 1,251 for girls. A recommendation

of 1350 kcal/day was determined to assure an average adequate caloric intake for both genders.

Calculations for macronutrient content were determined (Table 2) based on the Acceptable Macronutrient Distribution Ranges (AMDRs) from the Food and Nutrition Board of the Institute of Medicine (Trumbo et al., 2002). The AMDRs are: Fat 25-35 percent, Carbohydrate 45-65 percent and Protein 10-30 percent. The AMDRs and requirements for calcium (DRI: 800 mg/d) and fiber (Adequate Intakes (AI): 25 g/d) were established as goals for the RDFC.

Table 2. Macronutrient distribution for children 3-6 years of age based on a 1350 kcal/day diet.

Macronutrient	Macronutrient Distribution [1] (%)	Daily Caloric Intake (kcal)	Grams
Carbohydrate	55%	742	186
Protein	15%	202	51
Fat	30%	395	44
Total	100%	1350	----

[1] Based on the Acceptable Macronutrient Distribution Ranges (AMDRs) and complying with Dietary Guidelines for fat (USDA, 2000), American Academy of Pediatrics recommendation for fat ("American Academy of Pediatrics, Committee on Nutrition, Cholesterol in childhood," 1998).

Foods were selected to provide variety in the diet. The goal was to select as many different foods as possible with high nutritional value. The investigator observed for six hours what parents with children (3-6 years of age) bought at a local grocery store (Publix at Miami Beach). Popular food products among this age group of age children that were included in the RDFC list included: various flavors of low fat yogurt, flavored milk, cereals (various brands and flavors), fat free pudding (pre-prepared), and cheese (various brands and presentations).

Foods chosen for each RDFC food group included items from all food groups: bread, pasta, rice, cereals, raw and cooked fruits and vegetables, 100% fruit juices, fruit nectars, lean meat products, low fat yogurts, milk, cheese, nuts, and eggs. Foods were grouped as individual food items not as combination foods (e.g., pizza, tuna noodle, pot pie etcetera). No high fat foods (except for nuts and some cheeses) or high concentrated sweet foods were included. Unhealthy choices ("junk foods") were not included. No specific rules for nutrient content were established for food selection. However, foods were chosen considering their individual nutrient content and the amount of nutrients provided compared to the average nutrient content of the specific color group. Appendix D shows the nutrient content of each food item chosen.

Foods were grouped according to their color or closest color. Ten different colors that had at least seven food items were established. Each food group included more than seven foods giving the possibility of choosing a different food every day. Colors were only selected if children were familiar with them. Only one group consisted of two colors Black/Blue because blueberries were the only food listed in the Blue List. In order to

include blueberries in our food lists, the Black and Blue groups were merged. The final color groupings follow:

1. Black
2. Brown
3. Green
4. Gold
5. Orange
6. Pink
7. Purple
8. Red
9. Yellow
10. White

A serving size was determined for each food in the food groups (Appendix D). With the intention of facilitating learning, serving sizes were expressed as one whole unit and similar foods had the same measuring units, i.e.:

— "one container" was used to describe yogurts, pre-prepared puddings and milk that came in individual portions (approximately 6 oz)

— "one little box" was used to describe the small box presentation of cereals (1 oz)

— "one cup" was used to describe the portions of fruits and vegetables (diced or fruit sections) as well as other products such as rice, pasta and liquids

— "one diskette" was used to describe a slice of cheese (approximately 1oz)

– "one fist" was used to refer to refer to:

- the portion for meats (estimating portion of an average woman's hand equaling 3 ounces of meat)
- nuts (estimating portion of an average woman's hand holding 1ounce of peanuts in her hand)
- olives (estimating portion of an average woman's hand holding 1ounce of olives, approximately 7-10 olives).

The RDFC included serving sizes for each food item in the food lists (Appendix C).

Calorie, carbohydrate, protein, fat, fiber and calcium contents of each food item were determined. Appendix D displays all food items, their nutrient content, and the average nutrient content for portion size per color group. Food portions were edited in order to comply with dietary goals for children ages 3-6 years. Appendix C contains the final nutrient list and modified portion sizes.

In addition to the ten color groups developed by the investigators, another group was included as part of the RDFC. The Milk Group was included as a separate group (the eleventh group) to assure adequate intakes of calcium and protein necessary for growth (Appendix B). The milk group consisted of two cups of milk, which together with the other foods from the RDFC assure compliance with the DRI of 800 mg of calcium.

The values for each macronutrient, fiber and calcium in each color group were added and divided by number of foods in each color group to see if on average, consuming foods from each color group every day would provide adequate nutrition for a 3-6 year old child (Table 3). In this calculation the milk group was included to assure

adequate calcium intake. The average amount of the macronutrients, fiber and calcium provided by each color group and the milk group is referred to as the theoretical model.

Table 3. Mean nutrient content by the food color group (theoretical model).

Food Group Color	Energy (kcal)	CHO (g)	Protein (g)	Fat (g)	Fiber (g)	Calcium (mg)
Black	155	28.3	7.3	1.4	5.8	62.4
Brown	150.1	29.1	6	2.9	3.2	85.6
White	124.2	13.3	8.3	4.2	5.5	133.1
Red	95.4	17.8	2.9	1.4	2.9	84.9
Pink	144.2	18.6	7.1	4.6	3.2	58.0
Orange	111.5	25.1	2.1	0.3	2.8	34.2
Golden	146.8	19.0	7.8	4.4	1.4	74.1
Yellow	105.7	20.3	3.2	1.3	3.1	43.1
Green	51.6	10	2.9	0.0	3.5	52.6
Purple	105.7	12.6	1.0	5.7	1.9	27.2
Milk group	240	24.8	17.2	8		628.0
Total	1430	214.8	65.8	34.2	33	1283

Based on theoretical model findings, the criteria for food group formation were reevaluated as follows:

a. Primary criteria: Based on color or closest color

b. Each color group may provide on average 118 kcal (118 x 10 groups =1180 kcal plus the milk group that provide 240 kcal, resulted in approximately 1420 kcal). Inclusion of an additional group, the milk group, will fulfill the calcium, protein and energy requirements.To assure compliance with the dietary goals,

guidelines for RDFC use were next established. A suggested daily menu for the RDFC consisted of intake of one food item from each color group per day plus the milk group (2 cups of milk per day). The RDFC encourages selecting different foods from the same color group throughout the week. For example, if the child chose an apple on Monday from the Red Group, on Tuesday he/she should choose something different, like strawberries, and for Wednesday, a tomato.

Recommendations for cooking methods were also outlined. Methods recommended included broiling, baking, grilling and roasting. Cooking methods not recommended included frying and sautéing. The use of a cooking spray instead of oil, butter or margarine was recommended.

Products to be used in the RDFC included: lean meats, lean ham, lean sausages, milk 2%, low fat yogurt, 100% fruit or vegetable juice with no sugar added. A set of guidelines for measuring foods was also generated. These guidelines basically described the wording used to describe portion sizes (one container, one fist, one little box, etcetera). Appendix E contains the guidelines created for the RDFC.

Experiment 2: Focus Group Adjusted Model of RDFC

Purpose

The purpose of this experiment was to conduct a nutritional analysis using a theoretical one-week diet based on the food choices made by a focus group (composed of children/parents).

The following hypothesis was tested:

Menus created from foods chosen by the focus group (from the RDFC foods lists), will provide adequate nutrition for children 3-6 years of age.

Methodology

Subjects

Subjects participating in the focus group theoretical model were parents and/or children 3-6 years of age (n=7) waiting in the outpatient clinic of the Miami Children's Hospital. Permission from the Outpatient Clinic Director was obtained prior to the interviews (Appendix F)

Interactive Healthy Eating Index

The HEI, developed by the USDA Center for Nutrition Policy and Promotion, was used to assess diet quality. The HEI total score was used to evaluate diet quality while, the HEI variety sub-score was used to evaluate variety and the HEI nutrient intake scores were used to evaluate nutrient content. To obtain the HEI scores, the Interactive

Healthy Eating Index (IHEI) was used. The IHEI is an online dietary assessment tool (http://www.forcevbc.com/good/food.htm) and based on the HEI. Dietary intake information is entered and the data is analyzed. A HEI total score, HEI sub-scores and the HEI nutrient intake scores are provided.

Data Collection

Participation included a small informal interview where parents and/or the children waiting in the outpatient clinic were asked to verbally tell the investigator seven foods they liked the most from each color group of the RDFC.

The foods that were most frequently selected by children and/or parents were used to create a list for each food group. Each day's menu was constructed by randomly selecting foods from the list of food groups (focus group theoretical model). The menus were then analyzed to determine if, on average, the RDFC provided adequate amounts of nutrients necessary for children ages 3-6 years. The IHEI online software was used for dietary assessment.

The dietary assessment of the theoretical menu provided the HEI score, the HEI variety sub-score, and the HEI nutrient intake scores of RDFC diet. Specifically, the RDFC was analyzed for nutrient content such as: calories, protein, carbohydrate, dietary fiber, fat, saturated fat, monounsaturated fat, polyunsaturated fat, cholesterol, vitamin A, vitamin E, vitamin C, thiamin, riboflavin, niacin, folate, vitamin B6, vitamin B12, calcium, iron, magnesium, phosphorus, zinc, potassium, and sodium using the IHEI.

Results

Both parents and children participated in choosing of children's seven favorite foods from the RDFC food groups. Seven menus were constructed at random from the most frequently chosen foods (Tables 4 and 5) with the addition of two cups of milk by the investigator.

Each day's menu was analyzed to determine if, on average, the RDFC provided adequate amounts of nutrients necessary for children ages 3-6 years. Results for HEI score, HEI variety sub-score, and the HEI nutrient intake scores were compared to the national average provided by the HEI software (Tables 6 and 7).

Table 4. Seven most frequently chosen foods by color group.

Foods by Color Groups	Frequency (Out of 7))	Foods by Color Groups	Frequency (Out of 7))
Black		Pink	
1. Black beans	6	1. Ham	7
2. Bean soup	5	2. Turkey ham	7
3. Fried beans	5	3. Low fat yogurt bubble gum flavor	6
4. Raisins	5	4. Sausage	5
5. Lentil soup	4	5. Low fat yogurt (sugar candy flavor)	5
6. Blueberries	3	6. Pinto Beans	4
7. Blackberries	3	7. Shrimp	4
Gold		Yellow	
1. Macaroni	7	1. Banana	7
2. American cheese	6	2. Corn	6
3. Chicken breast	6	3. Pineapple	4
4. Crackers	6	4. Low fat yogurt (tropical fruit flavor)	3
5. Spaghetti	6	5. Scrambled eggs	3
6. Hamburger bun	4	6. Mango	2
7. Hot dog bun	4	7. Pancakes	2
Orange		Brown	
1. Mango	7	1. Lean meat	7
2. Melon	7	2. Ground meat	6
3. Orange	7	3. Chocolate Milk	5
4. Carrots (cooked)	4	4. Fat free chocolate Pudding	4
5. Orange juice	3	5. Bagel	3
6. Tangerine	3	6. Meat balls	3
7. Carrots, (raw)	3	7. Pear	2

Table 4. Continued

Foods by Color Groups	Frequency (Out of 7))	Foods by Color Groups	Frequency (Out of 7))
Green		Purple	
1. Cucumber	6	1. Grapes	7
2. Green grapes	6	2. Grape juice	6
3. Green apple	5	3. Prunes	5
4. Lettuce	5	4. Purple lettuce	5
5. Broccoli	4	5. Black olives	4
6. Peas	4	6. Plums	4
7. Avocado	3	7. Beets	2
Red		White	
1. Apple	7	1. Fried egg	5
2. Strawberries	5	2. Popcorn	5
3. Watermelon	5	3. Boiled egg	4
4. Cherries	4	4. Plain yogurt	4
5. Low fat yogurt (Strawberry flavor)	3	5. Rye bread	4
6. Tomato	3	6. Turkey breast	4
7. Vegetable soup	3	7. White rice	4

Table 5. A seven-day menu based on focus group results (focus group theoretical model).

Day One	Day Two
1. Bagel 2. Blackberries 3. Crackers 4. Grape juice 5. Orange juice 6. Peas 7. Pineapple 8. Popcorn 9. Low fat yogurt (sugar candy) 10. Watermelon 11. Two cups of milk	1. Black olives 2. Carrots cooked 3. Chicken breast 4. Low fat yogurt (tropical fruits) 5. Ground meat 6. Lettuce 7. Rye Bread 8. Lentils soup 9. Low fat yogurt (bubble gum) 10. Vegetable soup 11. Two cups of milk
Day Three	**Day Four**
1. Blueberries 2. Green grapes 3. Hamburger bun 4. Melon 5. Pancakes 6. Pear 7. Purple lettuce 8. Sausage 9. Tomato 10. Turkey breast 11. Two cups of milk	1. Apple 2. Bean soup 3. Broccoli 4. Fried egg 5. Hot dog roll 6. Fat free chocolate pudding 7. Mango 8. Orange juice 9. Pinto Beans 10. Grapes 11. Two cups of milk

Table 5. (Continued)

Day Five	Day Six
1. Avocado	1. American cheese
2. Beets	2. Black beans
3. Cherries	3. Carrots raw
4. Lean meet	4. Corn
5. Macaroni	5. Cucumber
6. Mango	6. Low fat yogurt (strawberry)
7. Plain yogurt	7. Meet balls
8. Raisins	8. Plums
9. Scrambled eggs	9. Turkey ham
10. Shrimp	10. White rice
11. Two cups of milk	11. Two cups of milk
Day 7	
1. Banana	
2. Boiled egg	
3. Chocolate milk	
4. Refried beans	
5. Green apple	
6. Ham	
7. Prunes	
8. Spaghetti	
9. Strawberries	
10. Tangerine	
11. Two cups of milk	

The RDFC theoretical one-week menu scored higher for: HEI total score, HEI score for variety, and for HEI sub-scores for cholesterol, fat and saturated fat. It also resulted in >100 percent of RDAs for all nutrients analyzed except for vitamin E (67%), iron (92%) and kilocalories (73%). Cholesterol was within the recommended <300 mg/day. Protein and fiber were above the recommendation of 24 g/day and10 g/day, respectively.

The nutrient content of the RDFC focus group theoretical model provided, met the recommendations for most macro and micronutrients and the amounts of nutrients provided by it were considered to be adequate. The RDFC total HEI score was 81.5, which surpassed the national average and indicates a "good" diet. The nutrient content of the RDFC focus group theoretical model was, therefore, determined to be acceptable.

Table 6. HEI total, HEI variety scores for a randomized seven-day menu using RDFC.

HEI [1]Component	Focus Group RDFC	National Average[2]
HEI variety score (out of 10)	10	7.8
Cholesterol (out of 10)	9.1	8.9
Total Fat (out of 10)	9.7	7.3
Saturated Fat (out of 10)	8.5	5.6
HEI score (out of 100)	81.5[3]	67.8

[1] HEI=Healthy Eating Index
[2] Provided by IHEI software
[3]HEI score: 80 implies "good" diet, 51-80 implies a diet that "needs improvement",< 51 implies a "poor" diet.

Table 7. Rainbow Diet For Children focus group theoretical model nutrient analysis.

Nutrients	RDFC[1] Focus Group Theoretical Model Mean	National Recommendation (DRIs[2])	Percent of Recommendation
Kcalories	1317	1800	73%
Protein (gm)	65	24	271% (18% of caloric intake)
Carbohydrate (gm)	189	--	-- (57% of caloric intake)
Dietary fiber	22	10	216
Fat (gm)	37	--	-- (25% of caloric intake)
Saturated fat (gm)	15	--	-- (10% of caloric intake)
Monunsaturated fat (gm)	14	--	--
Polyunsaturated (gm)	5	--	
Cholesterol (mg)	198	<300	
Vit A (RE)	1761	400	440%
Vit E (alpha-TE)	4.7	7	67%
Vit C (mg)	111	25	444%
Thiamin (mg)	1.3	0.6	219%
Riboflavin (mg)	1.8	0.6	302%
Niacin (mg)	11.3	8	141%
Folate (mcg)	303	200	152%
Vit B-6 (mg)	1.4	0.6	231%
Vit B-12 (mcg)	3.4	1.2	280%
Calcium (mg)	948	800	118%
Iron (mg)	9.2	10	92%
Magnesium (mg)	251	103	193%
Phosphorus (mg)_	1182	500	236%
Zinc (mg)	8.6	5	172%
Potassium (mg)	2993	--	--
Sodium (mg)	2011	2400	--

[1] RDFC= Rainbow Diet For Children.
[2] Dietary Reference Intakes =DRIs (Trumbo et al., 2002)

In terms of calories and macronutrients the eleven food groups for the RDFC provided levels of nutrients that met the established goals (Table 8). Both the theoretical model and the focus group theoretical model met or exceeded the established goal (1350 kcal). The RDFC theoretical model (TM) and the focus group theoretical model (FGTM) exceeded the carbohydrate recommendations (55% of total calorie intake). Carbohydrates provided 60% of caloric intake in the TM and 57% in FGTM. The TM and the FGTM exceeded the recommendation for protein (15% of total calorie intake). Both models provided more than 18-19% of calories from protein. Furthermore, both the TM and the FGTM complied with the dietary fat recommendation of <30% of total calorie intake provided by fat. The TM met the fiber intake goal by providing 132% of the recommendation. The FGTM however, met 88% of the goal for fiber. Finally, both models met the requirement for calcium. From the TM and the FGTM analysis, we determined that the food groups were adequately chosen. These results show that the TM of RDFC obtained by the focus group provided an adequate intake of all nutrients measured for a child 3-6 years of age. Table 8 shows a comparison between the dietary standards for RDFC (in terms of calories, macronutrients, fiber and calcium), and results for both theoretical models' nutrient analysis.

Table 8. Comparison of theoretical model and focus group theoretical model: macronutrients, fiber and calcium intakes with dietary standards.

	Energy (kcal)	CHO (g)	Protein (g)	Fat (g)	Fiber (g)	Calcium (mg)
Dietary standards	1350[1]	186[2]	51[3]	44[4]	25[5]	800[5]
% Of total caloric intake		55	15	30		
Theoretical Model	1430	215	66	34	33	1283
% Of total caloric intake		60	18	22		
Focus Group Theoretical Model	1317	189	65	37	22	948
% Of total caloric intake		57	19	25		

[1]Value adapted from the Schofiled formula. (Schofield, 1985)
[2]55 % of total caloric intake, AMDRs (Trumbo et al., 2002)
[3]15 % of total caloric intake, AMDRs (Trumbo et al., 2002)
[4]30 % of total caloric intake, AMDRs (Trumbo et al., 2002)
[5] Adequate Intakes (AIs), 2002 (Trumbo et al., 2002)

Discussion

As a result of Phase I (experiments 1 and 2) analysis, we were able to determine feasibility and value of the use of food groups based on color to promote healthy eating. The focus group theoretical model helped us to determine that the ten food groups plus milk were adequate to fulfill nutrient requirements of children 3-6 years old. We also determined that the list of foods developed for each food group was acceptable to the children and provided the basis of a healthy diet. At this point, modifications for food groups and food list of each food group were made as needed (portions sizes, adding more foods to food lists and editing lists).

Energy Intakes

The RDA recommendation for average daily energy requirements of children is based on observed energy intakes in groups of healthy, well-nourished children associated with normal growth (Fontvieille et al., 1993; Prentice, Lucas, Vasquez-Velasquez, Davies, & Whitehead, 1988). Children 4 to 6 years of age are expected to consume 90 kcal/kg (body weight) or 1800 kcal per day according to the 1989 Recommended Dietary Allowances. Several investigators have found that current requirements for energy are overestimated as calculations are based on intake estimates and not from direct assessments of energy expenditure. (Fontvieille et al., 1993; Kaplan, Zemel, Neiswender, & Stallings, 1995; Prentice et al., 1988; Schofield, 1985). Using the doubly labeled water method (which measures daily TEE directly) investigators have found that children 4-6 years only require 70 kcal/kg (body weight) per day (Fontvieille et al., 1993; Goran et al., 1993). Therefore, using TEE the total daily recommendation for

a 4-6 year old child (mean weight 20 kg) the calorie recommendation would be 1400 kcal/day. The RDFC's energy goal (1350kcal) meets 96% of the recommendation based on TEE.

The Schofield formulas, which include gender, weight and height to estimate REE values, were used to establish the caloric intake goal for the RDFC. Schofield et al. (1985) evaluated the data from 114 previous studies on REE for the past 80 years and published a different set of prediction equations. The utility of these equations in determining REE in healthy children has been accepted (Schofield, 1985). For these age ranges, REE recommendation goes from 750-950 kcal/day for boys and 718-789 kcal/day for girls. We proposed an intake of about 1350 kcal for both girls and boys after adding the AEE of 400 kcal/day (Goran & Treuth, 2001). This value is close to the 1400 kcal per day value obtained by doubly labeled water method (Fontvieille et al., 1993; Goran et al., 1993). Therefore, we conclude that our proposed value for energy intake for RDFC is appropriate for normal growth and development of children 3-6 years of age.

The values of 1350-1400 kcal/d are approximately 450 kcal/day lower than the current national recommendations (RDA). This explains why only 73% of the energy allowances were met by the RDFC. We are not concerned about not meeting the RDA for energy, as we believe that the methodologies used by Schofield et al.(1985), Fontvieille (1993) and Goran (1993) give a more precise value for energy intake. Given the rise in obesity rates among children we propose that the energy intake will be adequate and that the requirements of RDA must be reevaluated.

Protein Intakes

The 2002 Food and Nutrition Board of the Institute of Medicine report on dietary reference values for the intake of nutrients by Americans and Canadians presented Acceptable Macronutrient Distribution Ranges (AMDRs) for macronutrients. The AMDR is defined as a range of intakes for a particular energy source that is associated with reduced risk of chronic disease while providing adequate intakes of essential nutrients (Trumbo et al., 2002). The AMDRs for children ages 4-18 are daily calories divided as coming from: 10-30% for protein, 25-35 from fat and 45-65 from carbohydrate. The RDFC met the AMDRs requirements for protein providing 19% of total calories.

The RDFC provided 65 grams of protein based on both the TM and FGTM. This value exceeds the RDAs. The RDAs recommend 19-24 g of protein/day (Trumbo et al., 2002) or 1.1 g of protein/kg/day for 3-6 year age groups. However, the RDAs for children were designed by an extrapolation from short term nitrogen balance studies in infants (Millward, 1999). The protein requirements range from 1.6 g/kg body weight needed at six months of life to 1.0 g/kg body weight for the 7 to 14 year olds (Dewey, Beaton, Fjeld, Lonnerdal, & Reeds, 1996; Millward, 1999).

The protein content of the RDFC complies with the AMDR yet exceeds the RDA for chidrens' protein intake. Concern about excess intake of protein have been expressed, however the possible health risks are still controversial and further research is needed especially with children (Dewey, 2000; Millward, 1999).

Fat Intakes

Fat provided by the RDFC was in compliance with the Dietary Guidelines for fat (USDA, 2000), the American Academy of Pediatrics recommendations for fat and cholesterol intake ("American Academy of Pediatrics, Committee on Nutrition, Cholesterol in childhood," 1998) and with the AMDRs (Trumbo et al., 2002).

The dietary recommendations for fat, since 1980, have been to reduce total fat and saturated fat intakes. Excessive intake of total fat and high intakes of saturated fat have been correlated to the development of obesity, cardiovascular disease, diabetes, and certain cancers. However, the appropriate dietary fat intake, necessary for normal growth and development, which will not increase the risk of developing chronic diseases is not known ("Position of the American Dietetic Association: dietary guidance for healthy children aged 2 to 11 years," 1999). Since there is not a RDA for fat, The American Academy of Pediatrics Committee on Nutrition ("American Academy of Pediatrics, Committee on Nutrition, Cholesterol in childhood," 1998) recommends that children older than 2 years learn to consume only 10% of their total energy as saturated fat, 30% of calories from total fat (no less than 20% of total energy) and less than 300 mg dietary cholesterol per day.

Carbohydrates Intakes

The TM and the FGTM both complied with the current AMDRs for carbohydrates (45-65% of total caloric intake) for ages 4-18 years and exceed the DRI of 130g of carbohydrate per day. Furthermore, the DRI recommends that no more than 25% of the energy should come from added sugars. The RDFC food list does not include foods with

added sugars. The RDFC was designed to provide a variety of foods that have the additional advantage of having a low glycemic index.

Fiber Intakes

Both TM provided fiber amounts greater than the 1989 RDA (10 g/day) and the DRI for fiber (19-25). Another recommendation used for dietary fiber for children 2 years and older is to increase fiber as they get older using the formula age plus 5 g per day (Williams, 1995), and to have intakes of 25 to 35g per day by 20 years of age. However, 25 g of fiber is adequate for children 4-8 years of age according to the Adequate Intakes (AIs), which may be used as a goal for individual intakes. Based on AI recommendation, the RDFC provides a slightly higher intake of fiber (22-33 g).

Dietary fiber decreases the risk of several chronic diseases, including cardiovascular disease, overweight and obesity, diabetes, and colon cancer. Diets high in fiber contain less fat, cholesterol, and energy than diets low in fiber (Trumbo et al., 2002; Williams, 1995). Therefore high fiber provided by RDFC should be viewed positively.

Calcium Intakes

Bone mineralization is mostly determined by genetics and is strongly determined by nutrition and activity (Leonard & Zemel, 2002). Studies have shown that in order to attain the maximum bone mass, diet must meet the threshold of calcium needed to satisfy the needs of the skeleton (modeling and remodeling). Only when calcium intakes are adequate can optimal bone mineralization occur. However, the precise amount of calcium needed for optimal growth and to maximize the peak bone mass later in life is still

controversial (Dibba et al., 2000) Furthermore, it remains unclear how the increments of bone mass during childhood affect the peak bone mass, achieved in most bone sites during the first three decades of life. Nevertheless, there is a recognized importance of complying with the calcium recommendations. It has been recommended that 60% of the RDA for calcium be from dairy sources due to its higher bioavailability (Infante & Tormo, 2000).

The RDFC recommended the consumption of two cups of milk to comply with the DRI of 800 mg of calcium. Data on calcium requirements of young children (2-12 years of age) is limited (Baker et al., 1999). However, research has identified calcium levels that are beneficial and levels that have a negative effect in children's bone health. Research has shown that low calcium intakes of 443 mg /day and 105 mg/day have negative effect on bone health (Black, Williams, Jones, & Goulding, 2002; Infante & Tormo, 2000). In contrast, beneficial effects of calcium in bone health were seen with intakes of 565-630 mg/day, 1180 mg/day, 1056 mg/day Ca-carbonate and 1100-1200 mg/day Ca-Phosphate (Bonjour et al., 1997; Boot, de Ridder, Pols, Krenning, & de Muinck Keizer-Schrama, 1997; Dibba et al., 2000; Kalkwarf, Khoury, & Lanphear, 2003). Moreover, intakes of 800 mg/day have been associated with adequate bone mineral accumulation in prepubertal children (Baker et al., 1999). Calcium intakes higher than the 1989 RDA may decrease the risk of developing osteoporosis later in life (Dibba et al., 2000; Kalkwarf et al., 2003). Whether a higher intake (>800 mg) of calcium could benefit children remains controversial.

PHASE II

Experiment 1: Field Testing of Rainbow Diet for Children

Phase II, experiment 1 consisted of actual testing of the RDFC as an educational tool with children. We compared the RDFC with the most commonly used teaching tool; the Food Guide Pyramid (FGP) for Young Children 2 to 6 years of age. The RDFC and the FGP methodologies were compared to a non-intervention group (the control group). In this phase of the study, we evaluated the childrens' nutrient intake when following the RDFC and FGP.

The following hypotheses were tested:

Hypothesis 1: Children who follow the RDFC will have improved Healthy Eating Index scores (HEI), measured by the Interactive HEI, pre-to-post intervention and compared to children who follow the "Food Guide Pyramid for Young Children 2 to 6 years of age" (FGP) and the control subjects who will receive no intervention.

Hypothesis 2: Children who follow the RDFC will have a higher HEI sub-score for *variety* pre-to-post intervention compared to children following the FGP and a control group.

Hypothesis 3: Children who follow the Rainbow Diet will score higher on the HEI nutrient intake scores (which consists of DRIs for a number of nutrients established

by the Institute of Medicine and Food and Nutrition Board, 1989) pre-to-post intervention compared to FGP and the control groups.

Subjects

The subjects (n=22) for Phase II, experiment 1 were all normal, healthy children 3-6 years of age. Subjects were recruited at the two campuses of the Alexander Montessori School located in Miami, Florida.

The Parents' Association invited the investigator to present nutrition information to their schools. The study was explained to the Parent Association Committee, which agreed to have their schools participate in the study. The study was then explained to all parents in a letter that was sent to them by mail through the schools. Parents were asked to sign an informed consent document and to send it back to the schools. The letters were collected by the investigator (Appendix G). Parents were also asked to fill out a Contact Information Sheet (Appendix H), which provided the parents' name and telephone numbers as well as addresses. The Contact Information Document also inquired about parents' ethnicity and education, child's age, weight and height. The Contact Information Document was sent back to the schools by the parents and collected by the investigator at a later date prior to the commencement of this part of the study.

Children were included in the study if they met the following inclusion criteria:

- Ages 3-6 years of age
- Healthy
- From any ethnic background
- Voluntarily agree to follow the assigned regimen for two weeks (both parent and child)
- Return six food records (two for baseline and four for the experimentation weeks).
- Have a signed, parental informed consent form (Appendix G)

Children were excluded from the study if they had the following:

- No returned, signed informed consent document
- Chronic illness or any medical condition such as:
  - Asthma, mental retardation, Down's syndrome, diabetes, sleep apnea, hypercholesterolemia, hypertriglyceridemia, hypertension, food allergies, hyperlipidemia, psychosocial disorders (as per parental report).
- Incomplete or missing food records.

The IRB approval was obtained from the Florida's International University Institutional Review Board committee (Appendix A).

Prior to the nutrition education intervention, all children (n=240) in both schools were invited to participate as the non-intervention group. The control group did not receive a special regimen or nutritional advice.

Methodology

Nutrition education sessions (group delivery methodology) were used for the experimental sessions. The education sessions were presented to children in small classes of 16-17 children. Participating parents were invited to attend the sessions if they wished. Classrooms were randomly assigned to either RDFC or the FGP groups. Rainbow Diet for Children and FGP name tags were placed in a box and randomly drawn and assigned to treatment group. Table 9 provides the list of study groups and the food guide intervention that was assigned to it.

Nutrition education sessions were presented to 240 healthy preschool children. Only the children who followed the protocol thoroughly (returned 6 completed food records) were selected to be part of the study.

For the education sessions, the investigator presented and explained one of the two interventions (the RDFC or the FGP) to children and their parents in each class using visual aids. Each class presentation took approximately 30 minutes.

The presentation consisted of three parts. The first was a brief simplistic introduction to food and its role and function in the human body. The second consisted of the RDFC or FGP presentation. An explanation of the icons was provided as well as a complete description and explanation of the food groups. An example of menu planning for a day using either the RDFC or FGP was presented. The last part of the class consisted of a session of questions and answers from the children and the parents.

Table 9. Randomly assigned Study Groups

Group	School	# of children	Treatments
1. Blue Door	Campus I	30 children	Group I → FGP1 Group II → FGP2
2. Pink Door	Campus I	29 children	Group I →FGP3 Group II → FGP4
3. Violet Door	Campus I	30 children	Group I → FGP5 Group II → RDFC1
4. Yellow Door	Campus I	28 children	Group I→ RDFC2 Group II → FGP6
5. Aqua Door	Campus I	30 children	Group I → RDFC3 Group II → FGP7
6. Orange Door	Campus I	30 children	Group I → RDFC4 Group II → FGP8
7. Red Door	Campus II	31 children	Group I → RDFC5 Group II → RDFC6
8. Blue Door	Campus II	32 children	Group I → RDFC7 Group II → RDFC8

During the two week intervention period participating parents agreed to have their children follow the assigned dietary guidelines for two-weeks. The experimental groups were provided with a take home package of the food guide, further instructions on how to use it and record sheets to record their food consumption.

The instructions and materials to complete a 2-day dietary record are found in Appendix I. Participants completed food records for a total of 6 days (filled out by their parents) consisting of pre-and-post intervention food records. Each child had a 2-day baseline food record (pre-study food record) and 4 additional food records (2-day food records post intervention weeks 2 and 3).

The control group followed the same research protocol including the follow-ups but handed-in their food records prior to the nutrition intervention. All baseline food records and the control group food records (six food records) were collected before the nutrition intervention was instituted to eliminate contamination due to interventions. Food records were sent back to the schools and picked-up by the investigator at the end of each week. Parents were free to contact the investigators for any questions they might have had during the study. The numbers of calls were recorded.

All food records were analyzed for nutrient content and compared against the base line food record and across groups (RDFC, FGP and control).

Materials used in Phase II, Experiment 1 – the intervention study

Information materials were developed for use during the nutrition education sessions. Each intervention group RDFC and FGP had its unique materials packages:

RDFC Package:

The RDFC materials were designed so that both children and parents could understand them. The investigator provided the materials and gave guidance to parents and children together in a classroom setting. If parents missed the education intervention, materials were sent home with the children.

The parents and children of the RDFC group received four visual aids:

1. Food and color distribution in a shape of a Rainbow (Appendix B).
2. List of foods for each color group. This visual material also helped the children to keep track of the foods they ate throughout the week (Appendix C).
3. Instructions outlining the use of the RDFC (Appendix E).
4. Sample menus to exemplify daily menus using the RDFC (Appendix J).

The package also contained two sets of 2-day blank food records, as well as a sample page of a 24-hour food record (Appendix J). The same food records were used for post-intervention food recording. Also, instructions were provided with each food record page informing the parents how they should complete the food record.

Food Guide Pyramid package

Two visual materials were used for the FGP for Young Children (USDA, Center for Nutrition Policy and Prevention) (Appendix K). The first one displayed the Food

Guide Pyramid, the food groups, serving sizes and a short list of foods for each food group. The second visual material was a 16-page booklet, "Tips for Using the Food Guide Pyramid for Young Children 2 to 6 Years Old," which included the adapted pyramid graphic and accompanying information on good nutrition for children and a long list of possible foods for each food group. This material was produced by USDA and is in public domain. The booklet was downloaded from the Internet (http://www.usda.gov/cnpp/KidsPyra/PyrBook.pdf). It is also available through the Government Printing Office.

The FGP design is very child-friendly, "showing foods children recognize in an appealing graphic" (USDA, Center for Nutrition Policy and Prevention). It was designed with the intention to help parents and caregivers talk to their children about food choices and health. The Food Guide Pyramid for Young Children is based on actual eating patterns of young children.

The key message of the children's pyramid is variety (same teaching objective as the RDFC). The new FGP also emphasizes the importance of physical activity for good health. The graphic features many children playing actively around the pyramid and symbolizes how eating and activity work hand-in-hand. Like the traditional FGP, the children's pyramid emphasizes balanced meals, moderation and variety in food choices, with special emphasis on grain products, fruits and vegetables.

The FGP package also contained the two sets of 2-day blank food records as well as a sample page of a 24-hour food record (Appendix I). The 24-hour food record forms was taken from the United States Department of Agriculture's (USDA's) Team Nutrition Food Time Kit for elementary students.

Data collection Phase II, experiment 1

Two instruments were used to collect data to measure the intervention outcomes:

1. A 2-day Food Record
2. The interactive HEI online software.

2-day Food Record

Three sets of 2-day food records were obtained from each subject. One set was obtained at pre-intervention and the next two sets were obtained post-intervention. Food records were used to assess pre-and-post intervention nutrient intake in order to compare RDFC, FGP and the Control groups.

A sample page of a 24-hour food record, along with two blank record pages were distributed to all subjects on the first week of the study for baseline intake record.

Interactive Healthy Eating Index

The food record data was analyzed for dietary assessment using the IHEI. The HEI total score, HEI sub-scores and the HEI nutrient intake scores were obtained and analyzed.

Statistical Analysis

Descriptive statistics, frequencies and percentages were used to describe the study population. Paired samples t-tests were conducted to evaluate whether there were significant differences between the pretest and the posttest of each variable measured. Subjects were divided into 3 groups: RDFC, FGP and Control. One-way analysis of

variance was conducted to evaluate whether the mean change scores (post-test minus pre-test) in each of the 3 treatment groups differed significantly from each other. Finally, follow-up tests were conducted to evaluate pairwise differences among the means, using the Least Significant Difference (LSD) procedure, $p<0.05$ was accepted as statistically significant. For significant F-tests, Post hoc pair wise comparisons of groups was conducted using Tukey's Test at $\alpha = 0.05$ ($p<0.05$).

Results

Phase II, experiment 1

Parents of 240 children were sent two invitation packages (included letter inviting parents to participate and the letter of informed consent) as well as three letters to remind them to send back the letter of informed consent. Only 33 parents agreed to participate in the study and sent back the letter of informed consent. Eleven subjects were excluded from the study due to incomplete food records. Twenty-two subjects completed the six two day food records. Of these twenty-two children, seven were assigned to the control group, six to the FGP and nine to the RDFC group. The children's mean age was 4.5 ± 0.09 years, the mean Body Mass Index percentile was 65.9 ± 28.27. Twenty seven percent of the population was White, 31% was Hispanic and 40% was biracial. Nine percent of the parents reported "some schooling", 50% of the parents had undergraduate degrees and 40% had graduate degrees. Group demographics are presented on Table 10.

Table 10. Group demographics

	Total n=22	Control n=7	FGP[1] n=6	RDFC[2] n=9
Age (Mean ± SD)	4.5± .0.9	4.71	4.67	4.33
BMI (percentile, Mean ± SD)	65.9 ± 28.27 n=17	58±29 n=7	96 ± 3 n=2	58 ± 34 n=8
Female	9 (41%)	4 (57%)	3 (50%)	2 (22%)
Male	13 (59%)	3 (43%)	3 (50%)	7 (77%)
Ethnicity:				
White	6 (27 %)	2 (29%)	1 (17%)	3 (33%)
Hispanic	7 (32%)	4 (57%)	3 (50%)	0
Biracial	8 (36%)	1 (14%)	2 (33%)	5 (56%)
Arabic	1 (5%)	0	0	1 (11%)
Parents schooling:				
Some Schooling	2 (9%)	1(14%)	0	1 (11%)
Undergraduate	11 (50%)	5 (71%)	2 (33%)	4 (44%)
Graduate School	9 (41%)	1 (14%)	4 (67%)	4 (44%)

[1]FGP=Food Guide Pyramid
[2]RDFC=Rainbow Diet for Children

Mean nutrient intakes were calculated for each study group for pre and post intervention. The pre-test HEI total score was 70-75 percent for all subjects and the variety score was 8-10. All subjects met 67-101 percent of the total DRI calorie requirements of 1800 kcal and all met the protein requirement (1989 RDA). All three study groups met the recommended DRI for carbohydrate (130 g) (Trumbo et al., 2002). The three groups consumed 29-31 percent of their calories from fat. For saturated fat the control group consumed 9.4 percent of calories as saturated fat. In comparison, the FGP and the RDFC consumed 11 percent (more than the 10 percent recommendation from the American Academy of Pediatrics). All study groups consumed less than 300 mg of cholesterol and met >100 percent of the RDAs' recommendations for all other nutrients (Table 11) except for the Vitamin E in both the control and FGP groups (86 percent and

50.47 respectively). Both the control and FGP groups had a sodium intake of <2400 mg. However, the RDFC group had higher sodium intake (2700 mg).

All three groups had a range HEI score of 66-73 and a variety score of 9.3-9.87 post-test. The three groups met 66-85 percent of the DRI for total caloric requirements and met the DRI protein requirement (2002 DRI). All groups met the 130 g of carbohydrate and had 30-31% of their calories from fat. The control and RDFC group met the recommendation for saturated fat (<10% of calorie intake). The FGP group consumed a higher percentage of saturated fat (12.3%). All groups consumed less than 300 mg of cholesterol. All three groups met all RDAs recommendation by ≥ 100 percent for all other nutrients (Table 12) with the exceptions of Vitamin E in both the control and FGP groups, folate in the FGP group, calcium in the control and iron in the FGP. All groups had an intake of <2400 mg of sodium.

Table 11. Pre-test HEI scores and nutrient intakes for study groups

HEI scores and Nutrient	Recommendations	Control (n=7) Mean ± SD	FGP[1] (n=6) Mean ± SD	RDFC[2] (n=9) Mean ± SD
HEI total score	80-100	75.37±8.6	70.8±10	75.23±9.6
HEI variety score	10	10±0	8.1±3.3	9.75±0.5
Kcalories (%)[3]		77.23±17	67.3±13.9	101.34±26
Kcalories (kcal)	1800	1390.25±307.4	1212.36±250.2	1697.88±477.9
Protein (%)[3]	24 gm	227.41±39.7	229.3±85.4	326.73±109
Carbohydrate (gm)	---	198.49±52.6	157.06±32.4	225.74±58
Dietary fiber (%)[3]	---	112±58.2	104.16±41.7	179.98±79
Fat (gm)	---	45.21±4.4	42.38 ±11.4	62.10±25
Saturated fat (gm)	---	14.52±6.3	15.5±6.3	22.2±9.7
Monounsaturated fat (gm)	---	16.21±3.7	15.9±4.1	25.19±11
Polyunsaturated (gm)	---	10.51±4.3	7.05±1.8	10.89±5
Cholesterol (mg)	<300 mg	161.60±58.1	117.07±57.76	201.07±111.3
Vit A (%)[3]	400 RE	122.71±52.4	188.71±100.6	236.31±82
Vit E (%)[3]	7 alpha-TE	86.6±37.1	50.47±22.2	113.94±32
Vit C (%)[3]	25 mg	480.40±265.6	375.10±312.6	590.86±354
Thiamin(%)[3]	0.6 mg	219.04±63	220.83±53.2	285.20±83.4
Riboflavin (%)[3]	0.6 mg	250±40.5	229.16±58.9	294.16±84.6
Niacin (%)[3]	8 mg	188.92±41	211.66±73.1	241.27±93.5
Folate (%)[3]	200 mcg	101.44±25.1	90.17±43.6	155.08±66
Vit B-6 (%)[3]	0.6 mg	177.38±38	213.89±72.8	273.33±85.4
Vit B-12 (%)[3]	1.2 mcg	194.64±111.8	212.5±80.5	1019.27±2090
Calcium (%)[3]	800 mg	85.32±41.4	76.10±39.6	128.11±50.8
Iron (%)[3]	10 mg	102.28±29.5	102.91±14.9	166.92±84.7
Magnesium (%)[3]	103 mg	168.55±54	129.85±42.8	231.05±57.6
Phosphorus (%)[3]	500 mg	184.82±44.2	184.09±37.3	273.65±73.3
Zinc (%)	5 mg	132.42±24.4	139.5±52.2	193.16±54.7
Potassium (mg)	--	2126.89±629.3	1739.94±661.5	2555.28±912.1
Sodium (mg)	2400 mg	2062.19±625.4	2036.19±451.7	2736.52±1108

[1] FGP= Food Guide Pyramid
[2] RDFC=Rainbow Diet For Children
[3] % of requirement met based on RDA, DRI or AI
[4] HEI score: >80 implies a "good" diet, 51-80 implies a diet that "needs improvement", and <51 implies a "poor" diet

Table 12. Post-test HEI scores and nutrient intake for study groups.

HEI scores and Nutrient	Recommenda-tions	Control (n=7) Mean ± SD	FGP[1] (n=6) Mean ± SD	RDFC[2] (n=9) Mean ± SD
HEI total score	80-100	73.09±7.3	66.9±5.4	68.83±24.8
HEI variety score	10	9.85±0.4	9.3±1.2	9.87±0.23
Kcalories (%)[3]		85.6±17.7	66.3±8	82.97±12.3
Kcalories (kcal	1800	1541.87±318.6	1256.11±105.3	1414.22±477.9
Protein (%)[3]	24 gm	251±63.3	221±34.3	266.49±40.1
Carbohydrate (gm)	---	214±52.9	151.65±10.2	187.46±46.6
Dietary fiber (%)[3]	---	123.28±50	100±10.8	166.8±80.2
Fat (gm)	---	53.05±13.68	43.75±9.6	49.4±10.1
Saturated fat(gm)	---	16.9±4.2	17.3±6.7	17±3.3
Monounsaturated fat (gm)	---	20.23±6.1	15.9±3.3	18.8±4.6
Polyunsaturated (gm)	---	11.46±3.5	6.76±1.5	9.8±4.9
Cholesterol (mg)	<300 mg	183.6±104.5	261±67.2	182±95.1
Vit A (%)[3]	400 RE	216±81.5	170±66.9	289±180.5
Vit E (%)[3]	7 alpha-TE	85±21.1	60±6.5	100±38.8
Vit C (%)[3]	25 mg	386±176.4	323±53.8	497±347.0
Thiamin(%)[3]	0.6 mg	300±195.36	156±16.61	297±166.4
Riboflavin (%)[3]	0.6 mg	257±52.8	225±60.7	299±78.9
Niacin (%)[3]	8 mg	210±71.2	137±36.5	209±72.4
Folate (%)[3]	200 mcg	100±33.3	98±16.3	135±49.7
Vit B-6 (%)[3]	0.6 mg	214±33.1	178±72.8	286±122.5
Vit B-12 (%)[3]	1.2 mcg	221±80	242±72.1	283±145.9
Calcium (%)[3]	800 mg	82±34.3	94±26	113±29.7
Iron (%)[3]	10 mg	110.5±35.6	87±15	120±33.8
Magnesium (%)[3]	103 mg	177±46.8	143±25	202±46.5
Phosphorus (%)_ [3]	500 mg	201.15±54.4	192±41	1319±3053.8
Zinc (%)[3]	5 mg	153±24.4	134±35.8	186±54.7
Potassium (mg)	--	2128±485.6	2028±334.5	2332.98±668.2
Sodium (mg)	2400 mg	2070±678.4	1833±148.6	2086.3±438.9

[1] FGP= Food Guide Pyramid
[2]RDFC=Rainbow Diet For Children
[3] % of requirement met based on RDA, DRI or AI
[4]HEI score: >80 implies a "good" diet, 51-80 implies a diet that "needs improvement", and <51 implies a "poor" diet

Paired samples t-tests were conducted to evaluate whether significant differences existed between the pre-test and the post-test of each variable measured (HEI score, HEI variety sub-score, and the HEI nutrient intake scores). For the control group, Vitamin A intake increased significantly ($p<0.005$) from pre-test (490.85±209.41 mg) to post-test (866.11±326.27 mg).

For the FGP group, the pre-test of cholesterol (117.08±57.77 mg) was significantly lower ($p<0.006$) compared to the post-test (216.39±67.17 mg) and pre-test thiamin (1.33±0.32 mg) was significantly higher ($p<0.022$) than the post (0.94±0.10 mg). No significant differences were found between any pre/post test measurements for the RDFC group. Results are summarized in Table 13.

Table 13. Variables found to be significantly different between pretest vs post-test in the three groups.

Group	Variable	Pre-intervention intake value (Mean ±SD)	Post-intervention intake value (Mean ±SD)	P value[1]
Control Group	Vitamin A(μg/d)	490.85± 209.41	866.11± 326.27	0.005
FGP[2]	Thiamin (mg/d)	1.33± .32	0.94 ± 0.10	0.022
FGP	Cholesterol (mg/d)	117.08 ± 57.76	261.39 ± 67.16	0.006

[1] $p<0.05$ was considered significant
[2] FGP= Food Guide Pyramid

A one-way analysis of variance was conducted to evaluate whether the mean change scores (post-test minus pretest) in each of the three treatment groups differed significantly from each other. The F test was significant for two of the variables measured: cholesterol $F(2,21)=3.65$, $p= 0.045$ and monounsaturated fat, $F(2,21)= 3.61$, $p=0.047$.

Follow-up tests were conducted to evaluate pairwise differences among the means, using the LSD procedure at a 0.05 significance level. The FGP had a significantly larger average cholesterol difference (post-pre) (144.32±77.99) than RDFC group (-18.20±155.23). The mean cholesterol intake in the RDFC group decreased from pre to post, whereas in the averages FGP and the control groups increased (Table 13). All pre and post intervention cholesterol intakes were within the recommended limits.

With regards to monounsaturated fat, the average post-pre difference in the RDF group (-6.38±10.13) was significantly larger than that of the control group (4.02±6.90). Here again, the average monounsaturated fat intake in the RDFC decreased from pre to post, whereas in the other two groups it was increased (Table 14).

Table 14. Mean change score (post-test minus pre-test) for cholesterol and monounsaturated fat between study groups.

Variable	Groups Compared	Mean	Std Error	P value [1]
Difference cholesterol	Control vs RDFC	40.28	58.37	0.498
	Control vs FGP	-122.22	64.44	0.073
	FGP vs RDFC	162.51[1]	61.04	0.015
Difference monounsaturated fat	Control vs FGP	3.98	4.38	0.37
	Control vs RDFC	10.40[1]	3.93	0.016
	FGP vs RDFC	6.42	4.12	0.37

[1] $p<0.05$ was considered significant

Discussion

Of the 33 children involved in the study only 22 completed the study protocol (66%). Inconsistent participation may have been due to the length of time involved to complete the study protocol and the burden of completing 6 food records. Completing food records takes time and effort from a busy parent. The small number of subjects limited the ability to look for significant differences between subjects who finished the study.

Nutritional Analysis Pre Intervention

All three groups in our study met >100 % of the RDAs except for vitamin E (control group 86.6 % and FGP group 50.47%) and energy (control group 77 % and FGP group 67 %) at pre-intervention. Vitamin E (Johnson, Smiciklas-Wright, Crouter, & Willits, 1992; Skinner et al., 1999) and energy intakes (Albertson et al., 1992; Zive, Taras, Broyles, Frank-Spohrer, & Nader, 1995) lower than RDA levels in healthy children ages 3-6 years have been reported in the literature and may be due to underreporting (Albertson et al., 1992; Skinner et al., 1999; Zive et al., 1995).

The Continuing Survey of Food Intakes II (CSFII) (Tippett KS, 1995) reported an intake of 1,543 kcal/day for preschool children; others have found similar findings (Albertson et al., 1992; Skinner et al., 1999; Zive et al., 1995). These values are close to the values we found for our subjects' pre-intervention caloric intake (control 1390 kcal/day, FGP 1212 kcal/day, RDFC 1697 kcal/day).

Vitamin E intake is associated with polyunsaturated fat intake (Skinner et al., 1999). The control group consumed 6.7%, the FGP 4.5% and the RDFC 6.9% of their

calories from polyunsaturated fat pre-intervention. Of the three types of fat (saturated, monounsaturated and polyunsaturated fat) the intake of polyunsaturated fat was the lowest among all our subjects pre-intervention. This may suggest the type of fat rather than the total amount of fat in the diet may result in low intake levels of polyunsaturated and vitamin E levels (all three groups complied with approximately 30% of caloric intake from fat). Sources of vitamin E are vegetable oils, nuts, seeds and fortified cereals. Low intake levels of vitamin E reported in the pre-intervention results may be due to underreporting or to a low consumption of these foods.

The pre-intervention HEI total scores were 75, 70 and 69 for the control, FGP and the RDFC groups, respectively. HEI score above 80 implies a "good" diet, a score between 51 and 80 implies a diet that "needs improvement" and a score less than 51 imply a "poor" diet. According to this definition of HEI score, all three groups in our study had diets that "needs improvement". The pre-intervention HEI variety sub-score was 10 for the control, 8.1 for the FGP and 9.75 for the RDFC group. Therefore, according to HEI scores the participant children were eating healthy prior to the nutrition intervention.

Sixty eight percent of our population provided information on weight and height from which the BMI percentiles were determined. The BMI for our population (n=17, 65± 28.27) indicates that, for these children, weight for height ranged from the 10^{th} percentile –84^{th} percentile. Four children had a BMI >84^{th} percentile which may indicate overweight while one had a BMI<10^{th} percentile which may indicate underweight. Children in our study had adequate nutrient intakes and 70% of the children had BMIs within the normal. The education level of the mothers involved in the study was high.

Eleven of the twenty-two (50%) mothers had undergraduate degrees and nine (41%) had graduate degrees. Only two mothers (9%) did not have an undergraduate degree. It has been shown that education level has a positive influence on dietary intake and overall health behavior as well as on HEI scores (Hann, Rock, King, & Drewnowski, 2001). BMI and the level of parents' education suggest that the population may have been eating healthy prior to the intervention.

Nutritional Analysis Post Intervention

The post-intervention nutritional analysis results showed that the children met most of the RDAs. The FGP group had five measurements that did not comply with the RDAs: saturated fat (12.3%), vitamin E (60%), folate (98%), calcium (94%), and iron (87%). The control group had two measurements that did not meet RDAs: vitamin E (85%) and calcium (82%). The RDFC group met all of the recommendations post-intervention. The results of the FGP group are consistent with other studies that have found deficiencies for vitamins E, folate, calcium and iron (Johnson et al., 1992; McKenzie et al., 1996; Skinner et al., 1999). The HEI total score for post intervention was lower for all three groups FGP (pre-intervention score 70, post-intervention score 66.9), RDFC (pre-intervention score 75, post-intervention score 68.3) and for the control group (pre-intervention score 75, post-intervention score 73). The HEI variety sub-score for all groups ranged from 9.3-9.9 compared to pre-intervention scores that ranged from 8.1-10.

The HEI variety scores for pre and post intervention where all in the 9-9.9 range. Only the FGP for pre intervention had a score of 8.1. To achieve a perfect score of 10 a

person must eat 16 different foods over a 3-day period. A 0 score is given if <6 foods are consumed in the 3-day period (Kennedy et al., 1995). For our population the HEI goal for variety is 8 different foods daily. Little information is available on the basis for scoring variety (Chung et al., 1996). Variety is the only component of the HEI that is measured over a 3-day period (other components are measured over a one day period). Furthermore, the FGP allows a maximum of 24 different foods and a minimum of 15 per day. Therefore, 16 different foods in a 3-day period seems a bit low. In our study the HEI sub-score variety tells us that our population was eating at least 8 different foods. Whether this is adequate needs further research. The limited ability of the HEI to measure variety is one limitation of our study as one of the goals of the RDFC was to increase variety.

The HEI total score measures the overall quality of an individual's diet by assessing the compliance to the FGP (sub-score 1-5 for the five major food groups), to the Dietary Guidelines for Americans (sub-score 6-8, fat and saturated fat consumption as a percentage of total food energy intake, and cholesterol intake), to a <2,400mg/day intake of sodium and to the variety sub-score (16 different kinds of food items over 3-day period). The HEI was used because it is the most current tool to measure overall diet quality, and incorporates nutrient needs and dietary guidelines in one measure (Kennedy et al., 1995). Measuring the RDFC using the HEI may have been counterproductive, as the RDFC does not follow the 5 major food groups: grains, vegetables, fruits, milk and meat. The RDFC is grouped by colors. For the HEI a total of fifty points out of 100 are given for FGP food group compliance. Nevertheless, post-intervention RDFC group scored 68.3%, similar to the FGP post-intervention score of 66.9%. Even though the

RDFC uses a different approach to meal planning, in our study population the overall results were similar between the FGP and RDFC groups for food group distribution, Dietary Food Guidelines, the recommendation for sodium and with the sub-score for variety.

Moreover, it has been demonstrated that HEI total score correlates with the RDA for energy and key nutrients. Research has found that high HEI scores (>80) correlate with >75 % of RDAs. (Kennedy et al., 1995). Therefore, a HEI total score measures adequacy of macro and micronutrients indirectly. For our three groups, all key micronutrients evaluated met >75 % of the RDAs (except for vitamin E and energy in the FGP group) regardless of the low (<80%) HEI scores. The most important goal to assure adequate nutrition is meeting all macro and micronutrients needs.

When the mean change scores (post-test minus pre-test) in each of the 3 groups were compared, cholesterol intake in the RDFC was significantly lower than in the FGP group. The RDFC group reduced the cholesterol intake significantly ($p<0.01$) compared to the FGP. The RDFC group may have decreased as a result of the suggested use of 2% milk, low fat yogurt, lean meat products, and cooking methods (broiling, baking, grilling and roasting). Peterson and Sigman-Grant (1997) have proposed more drastic fat-reduction strategies (use nonfat milk instead of 2% fat or whole milk or fat-modified products instead of full-fat products) which may help children comply with the current dietary recommendations. The FGP briefly mentions the use of 2% or 1% milk and lean meats as a "Fat Tip: two easy ways to reduce fat".

Limiting fat intake to 30 % of caloric intake and cholesterol intake to <300 mg for children is controversial. Some studies suggest that restricting fat intake in children may

have a negative impact on growth and development and even cause failure to thrive as a fat reduced diet may increase the risk for inadequate energy and micronutrient intake (Lifshitz, 1992; Lifshitz & Moses, 1989; Lifshitz & Tarim, 1996; Nicklas, Webber, Koschak, & Berenson, 1992; Vobecky, Vobecky, & Normand, 1995). However, data from the third National Health and Nutrition Examination Survey (Troiano & Flegal, 1998) showed that the prevalence of obesity increased regardless of the decrease in fat intake. Moreover, positive effects of reduced fat intake have been found. The Child and Adolescent Study for Cardiovascular Health (CATCH) demonstrated that following the Dietary Guidelines for Americans in children led to an increased consumption of vitamins and nutrient dense foods (Nicklas et al., 1996).

One measurement that is not accounted for in the total HEI score is the compliance to fiber recommendation. The interactive program measures compliance however it is not included in the total score. This may be important as fiber is related to a decreased risk of chronic disease and cancer. Fiber may also lower blood cholesterol levels and prevent diabetes and obesity (fiber may normalize glucose levels, bring early satiety and therefore decrease the consumption of calorie and fat dense foods) (Hampl, Betts, & Benes, 1998; Marlett, McBurney, & Slavin, 2002). Promoting the intake of fiber is very important in children. The population in this study had adequate intakes of fiber for pre and post intervention (>100% of RDA for both pre and post intervention).

The study intra group pre-and post-intervention comparison showed significant differences. Cholesterol intake was significantly ($p<0.006$) increased and thiamin significantly ($p<0.022$) decreased in the FGP group. There was a significant increase ($p<0.005$) in the vitamin A intake in the control group. Nevertheless, RDAs were met for

both thiamin and vitamin A (>100 % of requirement) and cholesterol was still below the 300 mg cutoff of the Dietary Guidelines for Americans for all groups.

For the inter group comparisons, the FGP group had a significantly larger average cholesterol intake change ($p<0.0.15$) than the RDFC group. Post-intervention cholesterol levels for the FGP group was the highest and reached 261 mg, however the level remained below the 300 mg cutoff of the Dietary Guidelines for Americans. For monounsaturated fat intake the RDFC group also had a significantly larger change ($p<0.016$) than the Control group. Monounsaturated fat provided approximately 11-12% of energy intake for all three groups post-intervention. Both the average cholesterol intake and the monounsaturated intake in the RDFC group decreased from pre-to-post, whereas the average of the other two groups increased.

Our findings support our hypothesis that it is possible to create an alternative meal planning system for 3 to 6 year old children based on pre-established food lists using color. The RDFC group had adequate nutritional intake while following the recommended meal plan.

The most significant problem faced in the study was the small sample size. Recruitment for a three-week study period was difficult and resulted in lack of interest and in a high dropout rate. Furthermore, it is possible that participating parents and children that finished the study were already aware of the importance of good nutritional practices for their child and eating healthy prior to the intervention, thus minimizing improvements due to the intervention (selection bias).

We cannot elaborate on the possibility of improving the diet using RDFC in comparison with FGP or the control group (hypothesis 1-3) since we did not find

statistically significant changes except for a few variables. Our small sample size and the lack of sensitivity of the instrument used to measure change (HEI) might be the cause of these results. Specifically the following factors might be cited as responsible.

1. Small sample size with prior good nutrition habits.
2. The limitation of the HEI variety sub-score (8 different foods per day). This scoring system allowed a high score in both the pre and post intervention measurements with only 8 different foods being consumed. We believe that eight different foods may be a small number. As mentioned earlier, the FGP recommends 15 different foods as a minimum and 24 foods as a maximum number of different foods. Furthermore, other recommendations also include a larger number of foods per day such as the Japanese recommendation of 30 different foods per day (Chung et al., 1996). Variety provides 10 points out of the total 100 points.
3. Lack of lower limits for components related to fat. Three of the 10 components of HEI are related to fat intake. A perfect score is obtained for all three components if you eat <30% of fat, <10% of saturated fat, <300 mg of cholesterol. This may represent a problem as low intakes of fat will still provide a perfect score for each 3 of the components and contribute a total of with 30 points.
4. HEI does not measure fiber intake.

Given the pre-intervention results for all groups, our population appeared to be eating healthy even prior to the study. We believe that a greater impact of a new tool like the

RDFC may be seen in populations in need of better nutrition such as an obese population. Further research is needed to test the efficacy of the RDFC as a possible tool for nutrition education.

One area that was not investigated during the protocol was the possibility of RDFC being an effective tool for improving nutrition knowledge of 3-6 year old children. However subjective information obtained during the presentations, suggest this possibility.

Subjective Findings

During the nutrition presentation at the schools, the children were very attentive. The interactive participation was very positive. Most of the children seemed excited and curious about the topics of nutrition and health. It seemed that all children in this school understood the link between food and health (specifically growing and preventing disease). The majority of the children appeared to understand that there is a difference between healthy and unhealthy. They seemed to understand that they had a choice in eating healthy and its positive effects. When asked if they ate healthy they all screamed "yes". Also, when asked to describe healthy foods most would begin with vegetables or fruits, or give the names of them (apples, carrots, bananas etc.). The ability to categorize foods as healthy and unhealthy has been found in a population similar to ours (Singleton et al., 1992).

When presenting the FGP using the poster provided by the USDA, children seem receptive and interested. When the interactive FGP was presented to them, with the intent

of using deductive material to reinforce the new information presented to them, it was difficult to get their participation. Children were not able to group foods into the FGP food groups. It was necessary for the presenter to help them in identifying the correct food group. It was only a small group of children that were able to mention foods for all the food groups. FGP servings were not discussed. This is consistent with the literature which suggests that children may have difficulty understanding classification systems that places foods into groups largely on the basis of their nutrients (Anliker et al., 1990; Contento, 1981; Michela & Contento, 1984; Singleton et al., 1992).

When presenting the RDFC, children seemed receptive, interested and attracted to the icon. When the interactive material was presented, most of the children participated. Answers to the interactive session came more as a team response when asked simple questions like "To which group do apples belong". It seemed that most children were able to group foods and identify the colors of foods. This could be the result of the known ability of children to discriminate and categorize well with colors (Bornstein, 1985). It could also be the result of categorizing food using a physical property. It has been demonstrated that children can classify foods better using physical properties (Matheson et al., 2002; Michela & Contento, 1984) and that color is the physical property that they choose first to classify foods (Matheson et al., 2002).

For all presentations, children seemed very curious about foods, eating, and diseases. For the question and answer session, we had a lot of participation. Many children raised their hands to ask questions. But more than questions, children were sharing with the group what they eat, and what they like to eat. Most of the foods they liked were "healthy". This could be explained by previous knowledge children might

have had about healthy foods that comes from their homes or school. It seemed that they knew what foods fitted the discussion. It was challenging for this age children to create a question from what was previously presented. Their questions were usually affirmations "Right that if you eat healthy you'll grow?" or "I eat very healthy because I like bananas, or my mother makes me eat eggs because it is good for me".

The presentation definitely encouraged healthy eating. Children appeared excited with the concept. They were encouraged to eat a variety of foods, to drink two cups of milk and to follow the food guide that was presented to them.

CONCLUSIONS AND RECOMMENDATIONS

The Rainbow Diet for Children complies with the RDAs for macro and micronutrients as well as with the Dietary Guidelines for Americans and the recommendation for dietary fiber. The eleven food groups chosen by color and content of: carbohydrate, protein, fat, calcium and fiber provide good nutrition for children ages 3-6. In terms of compliance with national recommendations, the RDFC can be an alternative methodology to the Food Guide Pyramid.

Due to small sample size, good eating habits at baseline for the subjects and lack of sensitivity of the diet analysis instrument, we could not detect significant differences between groups or pre-and post-intervention. However, for a small group of indicators such as cholesterol, there was a statistically significant difference between the RDFC and the other groups.

More research is needed in order to use RDFC in clinical settings with populations in need such as the obese children. Furthermore, research is also needed to measure and determine if learning advantages exist for children using RDFC. A more direct evaluation of the possible educational advantage of RDFC over the FGP is needed.

Rainbow Diet as a possible nutrition education tool: strengths, weaknesses, areas of opportunities and disadvantages.

The most important strength offered by the RDFC as a nutrition education tool is that it is a cognitively adequate tool; this will assure children understanding and may have a positive effect on their compliance. Secondly, it is easy to understand and follow

by both children and parents. Basic menus are easy to plan while providing adequate nutrition.

Weaknesses of the RDFC as a nutrition education tool revolve around its limitation to the food lists. Food intake is limited to the food lists by color. Elaborated menus are difficult to plan and all the foods from the lists are basic food items. Furthermore, combination foods (for example, pizza, stir fry) are hard to categorize in the color groups as they contain several colors and the amounts used for preparation are not similar to the portion sizes of the RDFC. Eating out could also be a challenge while following the RDFC, as restaurants have more elaborate dishes.

The RDFC has opportunities for further development. The RDFC could be adapted for other age groups, adjusting portion sizes to comply with specific calorie, macro and micronutrient needs. The RDFC could also include more foods for each color and could include combination food rules in order to provide adequate nutrition. The RDFC could also be used as a tool for the treatment of childhood obesity as this population is in need of new innovative methodologies to treat this disease.

Finally, the RDFC has the disadvantage of not teaching food groups or nutrients. The RDFC will increase variety in the diet and improve the children's nutrition but it may not provide enough information for children to make adequate food choices for different goals later in life. However, the RDFC does not intend to replace more advanced nutrition education that may be appropriate later in life.

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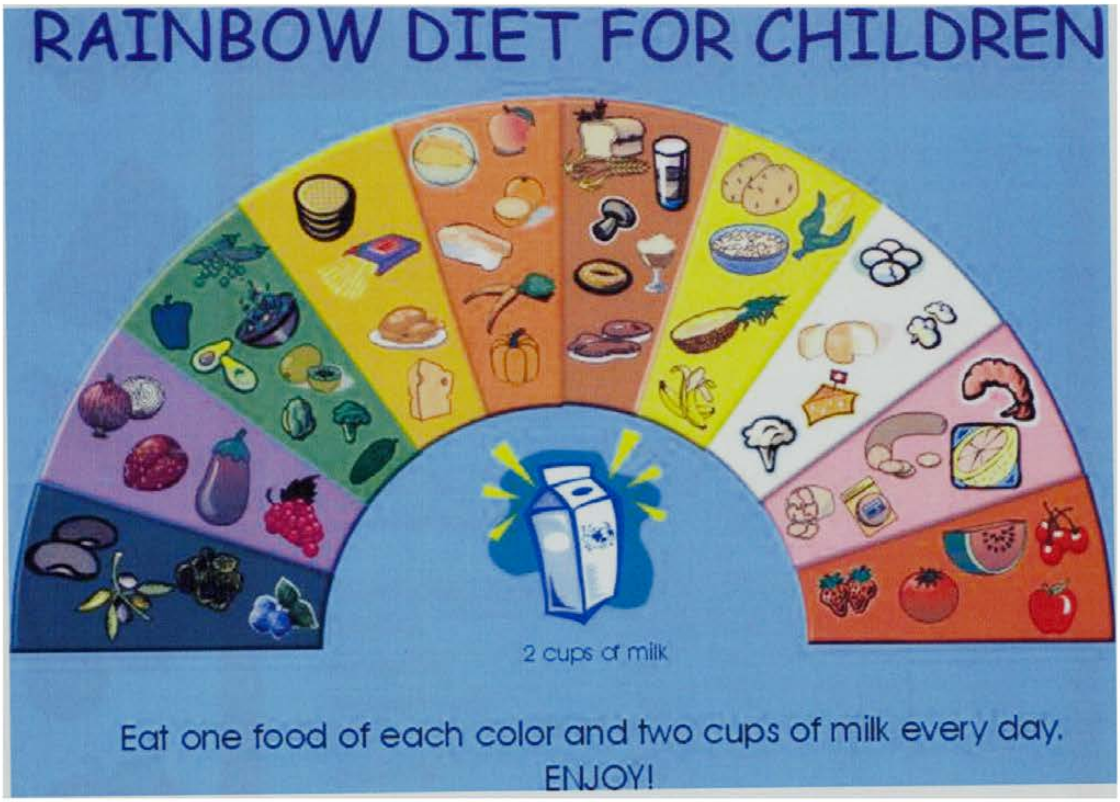
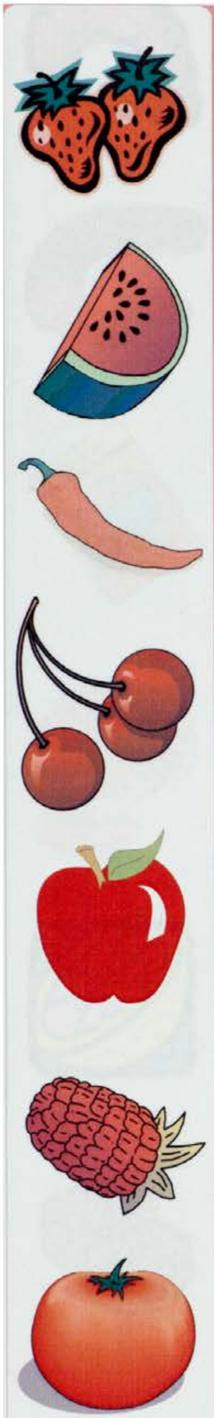
APPENDICES

Appendix A: IRB approval

Appendix B: Color distribution and milk for the Rainbow Diet for Children



Appendix C: Food groups and servings



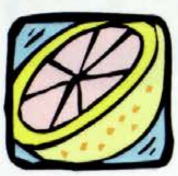
Red

Apple	One cup	M	T	W	Th	F	St	S
Cherries	One cup	M	T	W	Th	F	St	S
Cranberries raw	One cup	M	T	W	Th	F	St	S
Low fat yogurt cherry flavor	One container	M	T	W	Th	F	St	S
Low fat yogurt raspberry flavor	One container	M	T	W	Th	F	St	S
Low fat yogurt strawberry flavor	One container	M	T	W	Th	F	St	S
Minestrone soup	One cup	M	T	W	Th	F	St	S
Low fat milk strawberry flavor	One container	M	T	W	Th	F	St	S
Peppers, red bell boiled drained	One cup	M	T	W	Th	F	St	S
Raspberries	One cup	M	T	W	Th	F	St	S
Red grapefruit	One	M	T	W	Th	F	St	S
Red grapefruit juice	One cup	M	T	W	Th	F	St	S
Red pear	One cup	M	T	W	Th	F	St	S
Strawberries	One cup							
Tomato	One	M	T	W	Th	F	St	S
Tomato juice	One cup	M	T	W	Th	F	St	S
Tomato pure	One cup	M	T	W	Th	F	St	S
Tomato soup	One cup	M	T	W	Th	F	St	S
Low fat yogurt rainbow sherbet flavor	One container	M	T	W	Th	F	St	S
Low fat yogurt strawberry kiwi flavor	One container	M	T	W	Th	F	St	S
Low fat yogurt watermelon lavor	One container	M	T	W	Th	F	St	S
Vegetable juice	One cup	M	T	W	Th	F	St	S
Vegetable soup	One cup	M	T	W	Th	F	St	S
Watermelon	One cup	M	T	W	Th	F	St	S

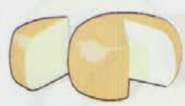
Pink

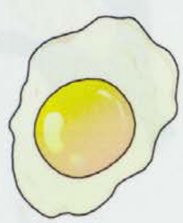







Fruit Loops	One little box	M	T	W	Th	F	St	S
Ham	One thick slice	M	T	W	Th	F	St	S
Hot dog sausage	One	M	T	W	Th	F	St	S
Kosher, sausage	One	M	T	W	Th	F	St	S
Low fat yogurt bubble gum	One container	M	T	W	Th	F	St	S
Low fat yogurt cotton candy flavor	One container	M	T	W	Th	F	St	S
Pink beans	One cup	M	T	W	Th	F	St	S
Pink grapefruit	One	M	T	W	Th	F	St	S
Pink grapefruit juice, raw	One cup	M	T	W	Th	F	St	S
Salami beef and pork	One fist	M	T	W	Th	F	St	S
Shrimps, fresh cooked in water	One fist	M	T	W	Th	F	St	S
Turkey ham	One thick slice	M	T	W	Th	F	St	S
Turkey sausage	One	M	T	W	Th	F	St	S

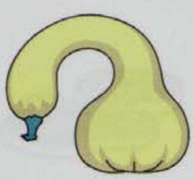




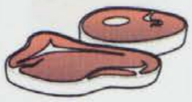
White

Cauliflower, cooked	One cup	M	T	W	Th	F	St	S
Cheese	One diskette	M	T	W	Th	F	St	S
Cottage cheese, reduced fat	One cup	M	T	W	Th	F	St	S
English muffin	One small	M	T	W	Th	F	St	S
Feta cheese	One fist	M	T	W	Th	F	St	S
Flour tortilla	One	M	T	W	Th	F	St	S
Fried egg	One	M	T	W	Th	F	St	S
Hard boiled egg	One	M	T	W	Th	F	St	S
Mozzarella cheese	One diskette	M	T	W	Th	F	St	S
Muenster cheese	One diskette	M	T	W	Th	F	St	S
Oatmeal ready to serve	One package	M	T	W	Th	F	St	S
Pita	One medium	M	T	W	Th	F	St	S
Plain yogurt 2%	One cup	M	T	W	Th	F	St	S
Popcorn, plain	One cup	M	T	W	Th	F	St	S
Provolone cheese	One diskette	M	T	W	Th	F	St	S
Ricotta, skimmed	One fist	M	T	W	Th	F	St	S
Rye bread	One sandwich	M	T	W	Th	F	St	S
String cheese Part Skim Mozzarella Cheese	One	M	T	W	Th	F	St	S
Swiss cheese	One diskette	M	T	W	Th	F	St	S
Turkey breast	One fist	M	T	W	Th	F	St	S
White Beans	One cup	M	T	W	Th	F	St	S
White Bread	One sandwich	M	T	W	Th	F	St	S
White Rice	One cup	M	T	W	Th	F	St	S

Yellow



Banana	One medium	M	T	W	Th	F	St	S
Bayo beans	One cup	M	T	W	Th	F	St	S
Cheerios	One little box	M	T	W	Th	F	St	S
Corn flakes	One little box	M	T	W	Th	F	St	S
Corn Pops	One little box	M	T	W	Th	F	St	S
Corn tortilla	One	M	T	W	Th	F	St	S
Corn, cooked	One ear	M	T	W	Th	F	St	S
Frosted flakes	One little box	M	T	W	Th	F	St	S
Kellogs19	One little box	M	T	W	Th	F	St	S
Mango	One cup	M	T	W	Th	F	St	S
Low fat milk banana flavor	One cup	M	T	W	Th.	F	St	S
Pineapple	One cup	M	T	W	Th	F	St	S
Pinto beans	One cup	M	T	W	Th	F	St	S
Potato, cooked	One medium							
Rice Krispies	One little box	M	T	W	Th	F	St	S
Scrambled eggs	One egg	M	T	W	Th	F	St	S
Shredded Wheat Miniatures	One little box	M	T	W	Th	F	St	S
Special K	One little box	M	T	W	Th	F	St	S
Waffle	One small	M	T	W	Th	F	St	S
Yellow grapefruit	One	M	T	W	Th	F	St	S
Yellow snap beans	One	M	T	W	Th	F	St	S
Yellow squash	One	M	T	W	Th	F	St	S
Low fat yogurt banana flavor	One container	M	T	W	Th	F	St	S



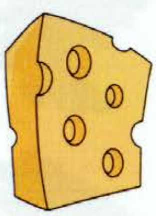
Brown

Bagel	One small	M	T	W	Th	F	St	S
Beef, lean, steak, broiled, grilled	One fist	M	T	W	Th	F	St	S
Bran Flakes	One little box	M	T	W	Th	F	St	S
Brown rice	One cup	M	T	W	Th	F	St	S
Chocolate milk 2%	One cup	M	T	W	Th	F	St	S
Ground lean meat	One fist	M	T	W	Th	F	St	S
Fat free Pudding	One container	M	T	W	Th	F	St	S
Kiwi	One cup	M	T	W	Th	F	St	S
Lean beef meat	One fist	M	T	W	Th	F	St	S
Meat ball beef	One medium	M	T	W	Th	F	St	S
Meat loaf	One fist	M	T	W	Th	F	St	S
Mushrooms cooked	One cup	M	T	W	Th	F	St	S
Nuts	One fist	M	T	W	Th	F	St	S
Peanuts	One fist	M	T	W	Th	F	St	S
Pear	One cup	M	T	W	Th	F	St	S
Portobello mushroom	One big	M	T	W	Th	F	St	S
Raisin Bran	One little box	M	T	W	Th	F	St	S
Whole grain bread	One sandwich	M	T	W	Th	F	St	S

Orange

Apricot	One cup	M	T	W	Th	F	St	S
Cantaloupe	One cup	M	T	W	Th	F	St	S
Carrot, cooked or raw	One cup	M	T	W	Th	F	St	S
Carrot, juice	One cup	M	T	W	Th	F	St	S
Crab	One fist	M	T	W	Th	F	St	S
Mango	One cup	M	T	W	Th	F	St	S
Mango Nectar	One small container	M	T	W	Th	F	St	S
Nectarine	One cup	M	T	W	Th	F	St	S
Orange	One cup	M	T	W	Th	F	St	S
Orange juice	One cup	M	T	W	Th	F	St	S
Papaya	One cup	M	T	W	Th	F	St	S
Papaya Nectar	One small container	M	T	W	Th	F	St	S
Peach	One cup	M	T	W	Th	F	St	S
Peach nectar	One small container	M	T	W	Th	F	St	S
Pumpkin, cooked	One cup	M	T	W	Th	F	St	S
Salmon	One fist	M	T	W	Th	F	St	S
Sweet Potato	One cup	M	T	W	Th	F	St	S
Tangerine	One cup	M	T	W	Th	F	St	S
Winter squash	One cup	M	T	W	Th	F	St	S

Gold



American cheese 2%	One diskette	M	T	W	Th	F	St	S
Cashews	One fist	M	T	W	Th	F	St	S
Cheddar cheese	One diskette	M	T	W	Th	F	St	S
Chicken, broiled, roasted	One fist	M	T	W	Th	F	St	S
Couscous, whole wheat	One cup	M	T	W	Th	F	St	S
Crackers	One small package	M	T	W	Th	F	St	S
Low fat yogurt tropical fruits flavor	One container	M	T	W	Th	F	St	S
Hamburger bun	One hamburger	M	T	W	Th	F	St	S
Honey Nut cheerios	One little box	M	T	W	Th	F	St	S
Hot dog roll	One hotdog	M	T	W	Th	F	St	S
Macaroni, plain cooked	One cup	M	T	W	Th	F	St	S
Noodles, plain cooked	One cup	M	T	W	Th	F	St	S
Pancake	One small	M	T	W	Th	F	St	S
Cheese Stick	One stick	M	T	W	Th	F	St	S
Spaghetti, plain cooked	One cup	M	T	W	Th	F	St	S
Swirls Mozzarella Cheddar Sticks	One stick	M	T	W	Th	F	St	S
Turkey, broiled, roasted	One fist	M	T	W	Th	F	St	S

Green

Artichoke	One	M	T	W	Th	F	St	S
Asparagus	One cup	M	T	W	Th	F	St	S
Avocado	One slice	M	T	W	Th	F	St	S
Broccoli, cooked or raw	One cup	M	T	W	Th	F	St	S
Brussels sprouts, cooked	One cup	M	T	W	Th	F	St	S
Cabbage, cooked	One cup	M	T	W	Th	F	St	S
Celery	One cup	M	T	W	Th	F	St	S
Collard greens, cooked	One cup	M	T	W	Th	F	St	S
Cucumber, diced	One cup	M	T	W	Th	F	St	S
Green apple	One cup	M	T	W	Th	F	St	S
Green beans, cooked	One cup	M	T	W	Th	F	St	S
Green bell peppers	One	M	T	W	Th	F	St	S
Green grapes	One cup	M	T	W	Th	F	St	S
Green salad	One cup	M	T	W	Th	F	St	S
Honeydew melon	One cup	M	T	W	Th	F	St	S
Kiwi	One cup	M	T	W	Th	F	St	S
Lentils	One cup	M	T	W	Th	F	St	S
Lettuce	One cup	M	T	W	Th	F	St	S
Peas	One cup	M	T	W	Th	F	St	S
Spinach, cooked, raw	One cup	M	T	W	Th	F	St	S
Turnip greens, cooked	One cup	M	T	W	Th	F	St	S
Zucchini with skin, cooked	One cup	M	T	W	Th	F	St	S

Purple

Beets, cooked	One cup	M	T	W	Th	F	St	S
Baba Ghannoj	One fist	M	T	W	Th	F	St	S
Eggplant, cooked	One cup	M	T	W	Th	F	St	S
Purple and green lettuce mix	One cup	M	T	W	Th	F	St	S
Grape juice	Half a cup	M	T	W	Th	F	St	S
Grapes	One cup	M	T	W	Th	F	St	S
Grape olives	One fist	M	T	W	Th	F	St	S
Plums	One cup	M	T	W	Th	F	St	S
Prune	One fist	M	T	W	Th	F	St	S
Purple onion	One fist	M	T	W	Th	F	St	S

Black

Bean soup	One cup	M	T	W	Th	F	St	S
Black beans	One cup	M	T	W	Th	F	St	S
Blackberries	One cup	M	T	W	Th	F	St	S
Black-eye Peas	One cup	M	T	W	Th	F	St	S
Blueberries	One cup	M	T	W	Th	F	St	S
Fried beans	One fist	M	T	W	Th	F	St	S
Lentil soup	One cup	M	T	W	Th	F	St	S
Raisins	One small box	M	T	W	Th	F	St	S

Appendix D: Food Groups by color and energy, carbohydrate, protein, fat, fiber and calcium content information.

Black Group

Black Group			Energy	CHO	Protein	Fat	Fiber	Calcium
Bean soup	1	Cup	240.0	43.0	16.0	1.0	4.4	49.0
Black beans	1	Cup	240.0	43.0	16.0	1.0	4.4	49.0
Blackberries	1	Cup	79.0	19.4	1.1		7.6	49.0
Black-eye peas			199.0	35.7	13.2	0.9	11.1	41.2
Blueberries	1	Cup	86.0	21.6	1.0	4.0		
Fried beans	1	Fist	94.0	15.5	5.4	1.3	5.3	35.0
Lentil soup	1	Cup	125.0	20.3	7.7	1.5	5.5	41.0
Raisins	1	Small box	130.0	33.0	1.0	0.0	2.0	
Trix Low fat yogurt Wild berry blue	1	Cup	120.0	23.0	4.0	1.5		172.5
Average			**155**	**28.3**	**7.3**	**1.4**	**5.8**	**62.4**

CHO= Carbohydrate

Brown Group

Brown Group			Energy	CHO	Protein	Fat	Fiber	Calcium
Bagel	1		126.5	25	4.3	0.75	0.15	
Beef, lean steak, broiled, grilled	1	Fist	35.45		6	1.1		2.1
Bran flakes	1	Little box	100	25	3	0.5	5	
Brown Rice	1	Cup, cooked	229	47.3	5.3	1.9	3.5	
Chocolate Milk 2%	1	Container	320	51	14	2		297
Ground lean meat	1	Fist	74.8	0	8.6	4.1		
Hershey's Fat free Calcium Fortified	1	Container	160	31	10	0		285
Jell-O Fat free Pudding	1	Container	100	24	2	0		89
Kiwi	1	One Cup		107	1.7	0.8	6	46
Lean beef meat	1	Fist	165		7	3		
Meat ball beef	1	Medium	165		7	3		
Meat loaf	1	Fist	165		7	3		
Mushrooms cooked	1	Cup	84	21.9	2.4	0.3	3.2	5
Nesquick Fortified	1	Cup	230	31	8	8		285
Nuts	1	Fist	195	3	2.6	20.4	2.7	19.8
Peanuts	1	Fist	89	5.9	3.7	6.1	2.4	15
Pear	1	Cup	97	25	0.6	0.6	3.9	18.2
Portobello Mushroom	1	Big	40	10	1.1	0.1	1.5	2.1
Raisin bran	1	Little box	130.0	30.0	3.0	1.0	5.0	20.0
Whole grain bread	1	Sandwich	134	28	5	1.4	1.6	29
Average			**150**	**25**	**6**	**3**	**3**	**82**

CHO= Carbohydrate

White Group

White Group			Energy	CHO	Protein	Fat	Fiber	Calcium
Cauliflower, cooked	1	Cup	23	2.7	1.8	0.45	2.7	16
Cheese	1	Diskette	105	0.9	7.9	7.6		269
Cottage cheese, reduced fat	1	Cup	214	8.7	32.8	4.6		164
English muffin	1	Small	144	27	5.1	1.5	0.5	
Fetta cheese	1	Fist	90		5	7		166
Flour tortilla	1	Medium	97	16.6	2.6	2.1		37.5
Fried egg	1	Piece	91	0.6	6.2	6.9		25.3
Hard boiled egg	1	Piece	78	0.6	6.3	5.3		29
Mozzarella	1	Diskette	106	7	8	4.5		183
Muenster	1	Diskette	120	8	10	8.5		200
Oatmeal Ready to Serve	1	Package	121.0	21.3	4.3	2.9	3.0	23.0
Pita	1	Small	82	15	2.4	0.4	0.3	
Plain yogurt 2%	1	Cup	152	3	4	4		314
Popcorn, plain	1	Cups	42	8.4	1.4	0.5	0.9	1
Provolone cheese	1	Diskette	120		8	8		246
Ricotta, skimmed	1	Fist	171	6.3	14	9.8		337
Rye bread	1	Sandwich	120	26	4.6	0.3	0.7	46
String cheese	1	Container	70	0	6	4.5		150
Swiss cheese	1	Diskette	105	0.9	7.9	7.6		269
Turkey breast	1	Fist	189		28	7.4		21
White beans	1	Cup	248	44	17	0.6	11.2	161
White bread	1	Sandwich	130	24	4	1.8		27
White Rice	1	Cup, cooked	211	45.7	4.2	0.5	0.9	5.8
Average			**124**	**13.3**	**8.3**	**4.2**	**5.5**	**133.1**

CHO= Carbohydrate

Red Group

Red Group			Energy	CHO	Protein	Fat	Fiber	Calcium
Apple	1	Cup	64	16.7	0.3	0.2	2.6	7.7
Cherries	1	Cup	104	24	1.7	1.3	3.3	21.7
Cranberries raw	1	Cup	49	12.7	0.4	0.2	4.2	6.6
Danimals Yogurt Raspberry Drinkable	1	Container	90	16	4	1.5		172
Danimals Yogurt Cherry Drinkable	1	Container	90	16	4	1.5		172
Danimals Yogurt Strawberry Drinkable	1	Container	90	16	4	1.5		172
Minestrone Soup	1	Cup	127	20.7	5	2.8	5.7	50
Nesquick Milk Strawberry 2%	1	Cup	230	31	8	8		285
Peppers, red bell boiled drained	1	Cup	40	9.6	1.3	0.3		27
Raspberries	1	Cup	64	15	1.2		6.4	
Red Grapefruit	1	whole fruit	74	18	1.4			
Red Grapefruit juice	1	Cup	102	24	1.3		0.3	22
Red Pear	1	Cup, sliced	103	26.3	0.7	0.7	5.2	18.2
Strawberries	1	Cups, sliced	47	11.1	1	0.6	3.5	21
Tomato	1	Medium	25	5.7	1	0.4	1.3	6.1
Tomato juice	1	Cup	42	10.6	1.9	0.1	0.9	67
Tomato pure	1	Cup	100	26	4.4		6	42
Tomato soup	1	Cup	109	20.5	2.6		1.2	56
Trix Rainbow Sherbet	1	Container	120	23	4	1.5		172
Trix Strawberry Kiwi	1	Container	120	23	4	1.5		172
Trix Triple Cherry	1	Container	120	23	4	1.5		172
Trix Yougurt Watermelon	1	Container	120	23	4	1.5		172

Watermelon	1	Cup, diced	54	12	1		1.8	
Vegetable Juice	1	Cup	49	11.6	1.6	0.2	0.9	26
Vegetable soup	1	Cup	221	9.7	9.7	1.9	0.4	7.2
Average			**95**	**18**	**3**	**1**	**3**	**85**

CHO= Carbohydrate

Pink Group

Pink Group			Energy	CHO	Protein	Fat	Fiber	Calcium
Fruit Loops	1	Cup	117	26	1.7	0.6	0.5	
Pink Beans	1	Cup	251	47	15	0.8	8.9	87
Pink Grapefruit juice, raw	1	Cup	102	24	1.3	0.3	0.3	22
Kosher, hot dog	1		115	3	5.8	8.7		42
Ham	1	Thick slice	36	0.2	5.4	1.3		1.9
Salami beef and pork	1	Fist	250		13.2	20		13
Shrimp, fresh cooked	1	Fist	84		17.7	0.9		33
Turkey ham	1	Thick slice	72		10.7	2.8		5.7
Trix Cotton Candy	1	Container	120	23	4	1.5		172
Trix Bubble Gum	1	Container	120	23	4	1.5		172
Turkey sausage	1		101		6.4	7.9		47
Hot dog sausage	1		115	3	5.8	8.7		42
Pink grapefruit	1	whole fruit	74	18	1.4			
Average			**144**	**19**	**7**	**5**	**3**	**58**

CHO= Carbohydrate

Orange Group

Orange Group			Energy	CHO	Protein	Fat	Fiber	Calcium
Apricot	1	Cup, whole	68	15.6	2	0.4	2.8	21
Cantaloupe	1	Cup, diced	59	14	1.5		1.2	17
Carrot, cooked or raw	1	Cup	74	17.3	1.8		4.5	34
Carrot, juice	1	Cup	104	24.1	2.5	0.4	2.1	
Crab	1	Fist	165		7		3	50
Mango	1	Cup sliced	113	29.6	0.9	0.5	3.5	16
Mango Nectar	1	small Container	142	36.6	0.7	0.1	1.6	
Nectarine	1	Cup, sliced	71	17.2	1.4	0.7	2.3	6.9
Orange	1	Cup, sections	89	22.3	1.8	0.2	3.4	79
Orange juice	1	Cup	118	27.3	1.8	0.5	0.3	27
Papaya	1	Cup, diced	58	14.5	0.9		2.5	33
Papaya Nectar	1	Cup	151	38.3	0.4	0.4	1.6	
Peach	1	Cup, sliced	77	19.9	1.3	0.2	3.4	8.5
Peach nectar	1	Cup	142	36.6	0.7	0.1	1.6	
Pumpkin, cooked	1	Cup	52	12.7	1.9		0	36
Salmon	1	Ounces, cooked weight	165		7		3	12
Sweet Potato	1	Cup	206	48	3.4		6	56
Tangerine	1	Cup, sections	91	23.1	1.3	0.4	2.1	27
Winter squash	1	Cup	114	30	2.2	0.2	9	90
Average			**112**	**25**	**2**	**0**	**3**	**34**

CHO= Carbohydrate

Golden Group

Golden Group			Energy	CHO	Protein	Fat	Fiber	Calcium
American cheese	1	Diskette	93	2.3	5.5	6.9		140
Cashews	1	Fist	300	14	9	23	1.5	37
Cheddar cheese	1	Diskette	132	8	11	9.2		201
Chicken broiled, roasted	1	Fist	119		21			10
Couscous, whole wheat	1	Cup cooked	212	43	6	0.3	2.1	12
Crackers	1	Small package	108	4.2	0.5	0.7	0.1	7.1
Danimals Tropical Tidle Wave Low fat Yogurt	1	Container	90	16	4	1.5		172
Hamburger bun	1	Small	134	24	3.7	2.5	0.9	
Honey Nut cheerios	1	Little box	90	18	2	1	1	50
Hot dog bun	1		134	24	3.7	2.5	0.9	
Kraft singles 2%	1	Slice	50	1	4	3		149
Macaroni	1	Cup cooked	183	39.3	7.9	0.8		5
Noodles	1	Cup cooked	225	42	8	3	3	5
Pancake	1	Pancake	169	24.9	5.2	5.1	0.9	74
Polly-o Twist-Ums Part Skim &Cheddar Cheese	1	Stick	60	0	6	4		150
Spaghetti	1	Cup cooked	209	41.9	7.1	1	2.4	2.52
Swirls Mozzarella& Cheddar	1	Stick	80	1	7	3		150
Turkey, broiled, roast	1	Fist	189		28	7.4		21
Average			**147**	**19**	**8**	**4**	**1**	**74**

CHO= Carbohydrate

Yellow Group

Yellow Group			Energy	CHO	Protein	Fat	Fiber	Calcium
Banana	1	medium	105	26.9	1.2		1.9	7.8
Bayo Beans	1	Cup	107	20.6	9.7			
Cheerios	1	Little box	60	13	2	1	1	99
Corn Flakes	1	Cup	111	25.9	2.1	0.1	0.8	4
Corn flakes	1	Little box	80	18	1	0	1	
Corn Pops	1	Little box	100	25	1	0	0	5.2
Corn tortilla	1	medium	67	12.5	4	1.1		42
Corn, cooked	1	ear	83	19	2.5	0.9	2.1	1.5
Danimals Tropical Tidle Wave Low fat Yogurt	1	Container	90	16	4	1.5		172
Frosted flakes	1	Little box	120	29	1	0	0	1.5
Kellogg's 19	1	Little box	80	19	2	0	1	4.8
Mango	1	Cup sliced	113	29.6	0.9	0.5	3.5	16
Nesquick Milk Banana	1	Cup	230	31	8	8		285
Pineapple	1	Cup, diced	80	20	0.6		2	10
Pinto Beans	1	Cup	107	20.6	9.7			
Potato, cooked	1	Medium	110	25	2.3		2.3	6.8
Rice Krispies	1	Little box	90	22	2	0	0	5.2
Scrambled eggs	1	egg	78	0.6	6.3	5.3	29	43
Shredded Wheat Miniatures	1	Little box	120	28	4	0.5	4	
Special K	1	Little box	70	16	4	0	0	9.3
Waffle, frozen	1	Small	58	10	1.6	1.4	0.3	20
Yellow grapefruit	1	Fruit	74	18	1.4			
Yellow Snap Beans	1	Cup	107	20.6	9.7			
Yellow Squash	1	Cup	151	7.7	1.6	0.5	2.5	48
Yogurt banana	1	Container	120	23	4	1.5		172
Average			**106**	**20**	**3**	**1**	**3**	**43**

CHO= Carbohydrate

Green Group

Green Group			Energy	CHO	Protein	Fat	Fiber	Calcium
Artichoke	1	Medium	60	13.5	4.2		0	54
Asparagus	1	Cup	60	10	6.4		4	18
Avocado	1	Slice	81	3.5	1		2.5	
Broccoli, cooked	1	Cup	54	10.4	6		4.3	46
Brussels sprouts, cooked	1	Cup	60	12	4		4	50
Cabbage, cooked	1	Cup	66	15	3		5	41
Cauliflower, cooked	1	Cup	62	12	5		5	
Celery	1	Cup	19	4.3	0.9		2	48
Collard greens, cooked	1	Cup	49	9.3	4		5.3	226
Cucumber, diced	1	Cup	14	2.9	0.6		0.8	16
Green apple	1	Cup	64	16.7	0.3	0.2	2.6	7.7
Green beans, cooked	1	Cup	43	9.8	2.3		4	58
Green bell peppers	1	Large	40	10	1.4			
Green Grapes	1	Cup	61	16.7	0.6		0.9	12
Green Salad	1	Cup	7.0	1.2	0.5			17.0
Honeydew Melon	1	Cup	59	15	0.7	0.1	1	10
Kiwi	1	Cup	107	1.7	0.8		6	46
Lentils	1	Cup	125.0	20.3	7.7	1.5	5.5	41.0
Lettuce	1	Cup	7.0	1.2	0.5			17.0
Peas	1	Cup, cooked	134	25	8.5		8.8	43
Spinach, cooked or raw	1	Cup	44	7	5.5		2.25	244
Turnip greens, cooked	1	Cup	30	8	1.5		3.3	34
Zucchini with skin, cooked	1	Cup	28	7	1		2.5	23
Average			**52**	**10**	**3**	**1**	**3**	**53**

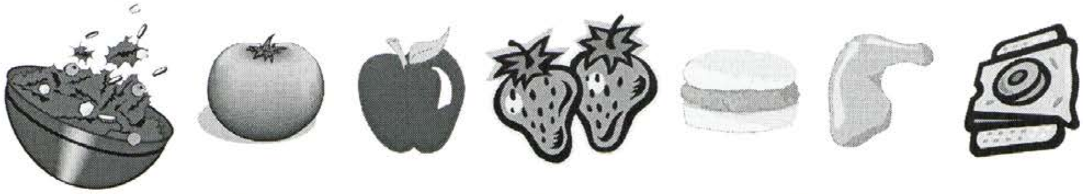
CHO= Carbohydrate

Purple Group

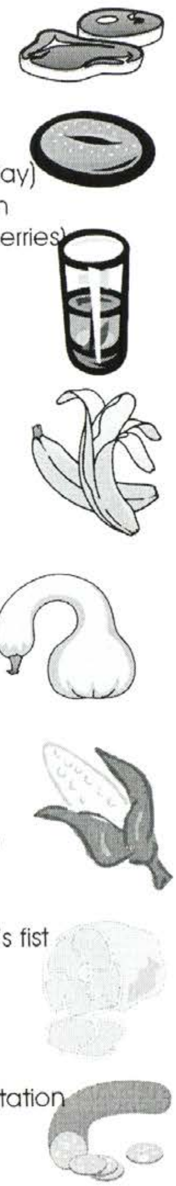
Purple Group			Energy	CHO	Protein	Fat	Fiber	Calcium
Baba Ghannoj	1	Fist						
Beets, cooked	1	Cup	56	12	1.9		4	26
Eggplant, cooked	1	Cups	28	6	0.8		2.5	5.9
Grape juice	0.5	Cups	80	20	0.8		0.15	
Grape Olives	1	Fist	115	6.26		10.68	3.2	88
Grapes	1	Cups	61	16.7	0.6		0.9	
Plums	1	Cup, whole	72	17	1		2.2	
Prune, dried	1	Fist	100	24	1		0	3
Purple and green lettuce	1	Cup	7.0	1.2	0.5			17.0
Purple Onion	1	Fist	43	9.9	1.3	0.8	2	23
Average		**106**	**62**	**13**	**1**	**6**	**2**	**27**

CHO= Carbohydrate

Appendix E: Instructions for Rainbow Diet for Children



Rainbow Diet For Children Basics



How it works

Choose one food from each color group every day
The milk group is part of the daily menu (2 cups of milk every day)
For the following days, try to choose a different food from each color group (e.g.. Red group: Monday- apple, Tuesday- strawberries)
Circle the day when you ate the foods to keep track

Cooking Methods

Allowed: Broiled, Baked, Grilled, Roasted
Not Allowed: Frying, Saute
Use cooking spray to cook (don't use oil, butter or margarine)

Product to use

Lean meat, lean ham, lean sausages
Milk 2 % fat
Yogurt low fat (not fat free)
Juice 100% natural

Measuring Foods

"One cup" of vegetables or fruits means one cup of diced or sliced fruits or vegetables (medium size) to fill up a cup

"One cup" of orange, tangerine, grapefruit means to fill a cup of these fruit sections.

"One fist" means to measure the food to the size of a woman's fist

"One diskette" means to slice the food to size and thickness of a computer diskette.

"One container" means to buy the store individualized presentation (kids size or the small size)

"One little box" refers to the small individual cereal box

Appendix F: Miami Children's Hospital permission from the Outpatient Clinic Director

FIU
FLORIDA INTERNATIONAL UNIVERSITY
Miami's public research university

PARENTAL CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Rainbow Diet: A New Nutrition Education Tool

My name is Maribel Cedillo. I am a graduate student at Florida International University. Your child is being asked to be a part of a research study. The purpose of this study is to develop a nutrition education tool *(Rainbow Diet for Children, RDFC)* that will encourage and aid parents to feed their children appropriately according to the national recommendations. If you decide that your child can participate in this study, it will only take half an hour during a weekday at their school setting.

Your child will receive a nutrition education class as part of the APA Montessori Enrichment Program during the second week of April. Children will attend the nutrition class as a group. Two nutrition education methodologies will be used, the *Rainbow Diet for Children* or Food Guide Pyramid. Schools will be randomly assigned to either methodology. During the session, children will receive an explanation on how to use the educational materials.

You will be asked to provide records of what your child eats and drinks for a period of 2-weekdays for a total of 3-5 weeks (two days food records each week). The food intake record is to be completed at home and returned to school at the end of the each week.

If you choose to let your child participate, this is what will be asked of him/her and from you:

<u>Week One: Agreement to participate in study and first Food Record.</u>

Child

- Take study information home.
- Eat normally.

Parents

- Agree to participate.
- Read and sign this letter of informed consent.
- Fill out contact information worksheet.
- Read instructions for 2-day food intake record.
- Fill out worksheets for 2-day food intake record. (Week 1)
- Send to school: 1) completed 2-day food intake record, 2) signed Parental Consent Form 3) Contact Information Worksheet.

<u>Week Two: Second Food Record</u>

Child

- Eat normally.

Parents

- Fill out worksheets for 2-day food intake record. (Week 2)
- Send to school the completed 2-day food intake record.

Week Three: Third Food Record

Child

- Eat normally.

Parents

- Fill out worksheets for 2-day food intake record. (Week 3)
- Send to school the completed 2-day food intake record.

<u>Week Four: Nutrition Education Session at School</u>

Child

- Participate in the Nutrition Education Session that will be held as part of the APA Montessori Enrichment Program.
- Follow food guide. (Rainbow Diet for Children or Food Guide Pyramid)

Parents

- **Attend and participate** in the Nutrition Education Session that will be held as part of the Montessori Enrichment Program. (Duration 30 min)
- Listen to explanation of nutrition education method.
- Agree to follow food guide for two weeks.
- Receive materials to follow food guide and food records.
- Help your child to eat following the food guide.
- Fill out worksheets for 2-day food intake record. (Week 4)
- Send to school the completed 2-day food intake record for week four.

Week Five: Last Week

Child

- Agree to follow food guide for a second week. (Rainbow Diet for Children or Food Guide Pyramid)

Parent

- Agree to follow food guide for one more week.
- Help your child to eat following the food guide.
- Fill out worksheets for 2-day food intake record. (Week 5)
- Send to school the completed 2-day food intake record for week five.
- At the end of the fifth week, you and your child will receive by phone or in person (what is most convenient for you) an evaluation of his/her eating habits based on the previous dietary records you have provided.

There is a minimal risk as a participant in this study. The tasks may become tiring after the first few minutes but your child is only expected to do his/her best. There are no good or bad scores. Your child may request to stop during a task and that will be allowed. You understand that you may discontinue your child's participation at any time without any penalty to him/her or to yourself.

The direct benefits to your child are: learning to eat a variety of foods and learning to control portion sizes. This will help him/her choose healthy foods and eat a balanced diet necessary for good health. You understand that this study may help researchers learn about nutrition education methods and how children learn healthy eating habits at young ages. This study will also help the researchers learn about ways to design nutrition education programs and material that are effective and that will prevent children from having nutritional deficiency diseases and/or nutrient over consumption, reducing the risk of future health problems. As a thank you for being a part of the study, at the end of the study, you will be able to keep the Nutrition Education materials used to continue teaching your child to eat healthy. You will also receive a nutrition assessment for your child including a dietary analysis and evaluation of his/her eating habits based on the previous dietary records you will provide.

You understand that if any information about nutrition education or dietary guidance is learned during your child's participation, which may affect you wanting your child to discontinue participation, you will be notified at once. A special code will be used to record your child's scores and your child's name will not be used when this research is presented. All files will be kept in a locked cabinet. The scores will be kept until the end of the study and then destroyed.

You understand that you or your child may ask questions now or later pertaining to this research. You understand that you can contact Maribel Cedillo at 305-866-3598 or Dr. Fatma G. Huffman at FIU Department of Dietetics and Nutrition at 305-348-2878 for answers to questions. If you have questions about your child as a research subject, you can contact the Chairperson of the Institutional Review Board at Florida International University, Dr. Bernard Gerstman at 305-348-3115 or 305-348-2494. Finally, you have been given a copy of this form.

I give permission for my child, ________________________________, to
Child's Name

participate in this research project.

______________________ ____________________________ __________
Parent's Signature Printed Name Date

____________________________ Date ____________
Witness

Appendix H: Contact Information Form

SCHOOL CAMPUS	Red Road	Old Cutler Road

Child's Name (Last, First)

Mother's Name (Last, First)

Father's Name (Last, First)

Telephone #

Alternative telephone

Address:

Child's information:

Age

Weight

Height

Parents information

Racial Ethnic Group

1. African American	2. Asian American	3. Pacific Islander American	4. American Indian and Alaskan Native
5. White	6. Hsipanic, Latino, Mexican American, PuretoRican	7. Multiethnic	8. Other:

Degree of study:

1. Some schooling	2. High school	3. Undergraduate School	4. Graduate School

Sample Form

FOOD/BEVERAGE	DESCRIPTION/PREPARATION	AMOUNT
Milk	2%	1 cup
Sugar	White	2 teaspoons
Doughnuts	Chocolate glazed	2 medium
Bread	Whole wheat	2 slices
Bologna	Reduced fat	2 slices
Mustard		1 tablespoon
Corn chips		1 oz bag
Apple		1 medium
Cola	Coke, Sprite	12 oz
Peanut butter	Regular	1 Tablespoon
Crackers	Brand	6
Meat loaf	Lean ground beef	Size of child's fist
Mashed potatoes		½ cup
Margarine		1 Tablespoon
Peas and onions	Microwave	½ cup
Dinner rolls	White	2small
Milk	2%	1 ½ cups
Popcorn	Microwave	2cups

The following food diary is an example of what one person might eat in a day. Two blank lists are included with the sample page. Please write down ***everything*** your child eats and drinks in a **24-hour** period (**from the time he/she wakes up to the time he/she goes to bed**) on these pages. On the left hand column, write down all the foods your child eats and drinks. In the middle column, write down the description of the food and how it was prepared. In the right had column, write down the amount of food that your child ate.

***Please describe all the extra ingredients that are added to a food. For example, if your child drinks chocolate milk using white milk, please add the amount of chocolate and /or sugar that is added to the milk (and the kind of milk (whole 2%, 1%, skim, etc).**

PIN_________ Date_______________

Record: Base Line First Week Second Week

24-Hour Food Diary

ONE

FOOD/BEVERAGE	DESCRIPTION/PREPARATION	AMOUNT

PIN__________ Date_______________

Record: Base Line First Week Second Week

24-Hour Food Diary

TWO

FOOD/BEVERAGE	DESCRIPTION/PREPARATION	AMOUNT

Appendix J: Sample Menus

RAINBOW DIET FOR CHILDREN©

SAMPLE MENUS

Day 1

Breakfast	
Milk 2%	One cup
Cornflakes	One little box
Orange	One cup (sections)
Snack	
Apple	One cup
Lunch	
Whole grain bread	One sandwich
Turkey ham	One thick slice
White Cheese	One slice
Dinner	
Bean soup	One cup
Noodles	One cup
Broccoli	One cup
Snack	
Grapes	One cup
Milk 2%	One cup

Day 2

Breakfast	
Milk 2%	One cup
Fried egg	One
Orange Juice	One cup
Snack	
Green Grapes	One cup
Lunch	
Banana	One medium
Low fat yogurt Candy flavor	One container
Raisins	One small cup
Dinner	
Spaghetti	One cup
Meat ball	One
Tomato sauce	One cup
Snack	
Prunes	One fist
Milk 2%	One cup

Day 3

Breakfast	
Milk 2%	One cup
Waffle	One small
Blueberries	One cup
Snack	
Grapes	One cup
Lunch	
Baby carrots	One cup
Munster cheese	One diskette
Bagel	One small
Dinner	
Vegetable soup	One cup
Chicken, roasted	One fist
Lettuce and spinach	One cup
Snack	
Fruit Loops	One little box
Milk 2%	One cup

Day 4

Breakfast	
Milk 2%	One cup
Melon	One cup
Scrambled eggs	One egg
Snack	
Cucumber, diced	One cup
Lunch	
Kosher, sausage	One
Mozzarella cheese	One diskette
Hot dog roll	One hot dog
Dinner	
Black beans	One cup
Lean beef meat	One fist
Purple and green lettuce mix	One cup
Snack	
Strawberries	One cup
Milk 2%	One cup

Maribel Cedillo
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Mobile: 786 348 8566
email: mcedil@yahoo.com

Appendix K: Food Guide Pyramid for Young Children ages 2 to 6 years of age

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