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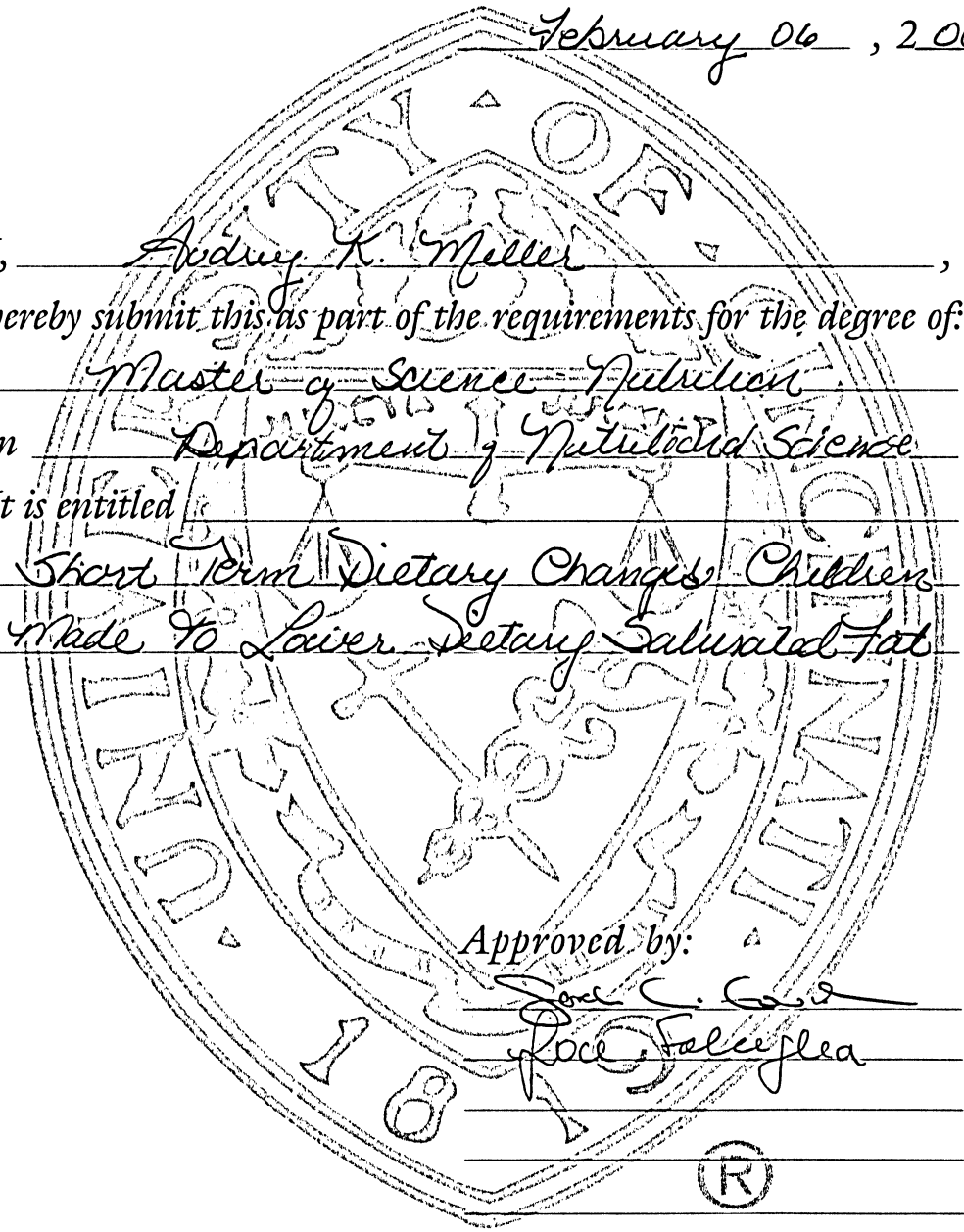

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SHORT TERM DIETARY CHANGES CHILDREN MADE TO LOWER DIETARY SATURATED FAT

A thesis submitted to the

Division of Research and Advanced Studies
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Abstract

This study investigated which foods and food groups were modified in the diets of children diagnosed with hypercholesterolemia to successfully lower their daily saturated fat intake after participating for 3 months in a clinic based dietary intervention program emphasizing the National Cholesterol Education Program (NCEP) Step I diet to lower serum cholesterol. Children completed 3 day food records which were analyzed prior to and at 3 months after receiving formal nutritional counseling. For statistical analysis, subjects were divided into two groups based on change in saturated fat intake over 3 months: Group I were those who reduced their intake of saturated fat and Group II were those who did not reduce their intake of saturated fat after 3 months. Demographic characteristics, absolute change in number of servings consumed from the different food groups and from the fat subgroups, were compared pre and post intervention using a chi-square analysis and student t-tests. Group I children consumed significantly less high fat dairy foods at 3 months as compared to Group II, and showed a trend ($p < .10$) for reduced intake of servings from the medium fat meats, eggs and medium fat fat/oil food groups. Overall children who reduced their intake of saturated fat did so primarily by decreasing their intake of high fat dairy products. This dietary change appears to be one of the most feasible and effective for achieving the NCEP recommendation for saturated fat intake in this population.

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I would like to thank and extend my deepest appreciation to Dr. Sarah Couch and Dr. Grace Falciglia for all their assistance and support extended me over the past year with this research project. Dr. Couch's level of professionalism, academic excellence and commitment to the field of nutrition has given me guidance and inspiration of the highest level during this research process. Also a special thanks to my husband, for his encouragement, support and patience during this time.

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Introduction

Good nutrition in childhood and adolescence is essential for achieving maximum growth and optimal health. Knowledge of healthful eating, when applied, can also help to deter/prevent chronic diseases into adulthood. There is currently much evidence supporting the fact that cardiovascular disease (CVD) and associated risk factors, begin in childhood (1). Therefore, measures that can delay or prevent the progression and development of CVD such as therapeutic diet intervention should be targeted for children and adolescence at risk.

The Expert Panel on Blood Cholesterol Levels in Children and Adolescences and the National Cholesterol Education Program (NCEP), along with the American Academy of Pediatrics (AAP), American Heart Association (AHA), and the National Institute of Health (NIH) have established and recommended specific dietary guidelines for maintaining heart health and for lowering elevated LDL cholesterol levels in children greater than 2 years of age. These guidelines (also referred to as the NCEP Step I Diet) include consuming a diet that contains less than or equal to 30% of total calories from fat, less than or equal to 10% of calories from saturated fat, and less than or equal to 300mg of cholesterol per day. Also included in these dietary guidelines is the recommendation that children consume an adequate supply of total calories and a variety of foods, to support desired body weight and sustain optimal growth and development. Current research has demonstrated that the Step I Diet is effective in lowering elevated lipids as well as safe for promoting and sustaining growth and development (2-3). For children and adolescents diagnosed with elevated LDL cholesterol levels, adherence to a nutritional therapy plan that follows the NCEP Step I guidelines is widely recognized and

accepted as the first step in the optimal management of this disorder. What dietary behaviors among children and adolescents should be the focus of nutritional intervention to lower dietary fat? What dietary strategies can be utilized by this age group to promote sustained compliance to these guidelines over an extended period of time? Designing a successful nutrition intervention program for youth requires knowledge of these factors. Before successful strategies can be developed however, nutrition educators need to be knowledgeable of which dietary changes are the most feasible and which changes will have the greatest impact on lowering dietary saturated fat and cholesterol to recommended levels, as well as lowering serum cholesterol among this population. The purpose of this study was to assess which foods and food groups were modified in the diets of children with hypercholesterolemia, to successfully lower their daily saturated fat intake after participating for 3 months in a clinic based nutrition intervention program, to lower serum cholesterol.

Review of Literature

The following literature review will examine current evidence supporting early intervention to manage hypercholesterolemia in childhood. This will be followed by a detailed discussion of recommended dietary approaches for treating high blood cholesterol in this population, including specific nutrient recommendations and their safety and efficacy. Additionally, successful strategies for implementing low fat diets in childhood will be discussed.

Rationale for Early Intervention of Hypercholesterolemia

Coronary heart disease (CHD) is one of the leading causes of death in the United States as well as worldwide (4). The major underlying cause of CHD is atherosclerosis, which involves structural and compositional changes in the innermost layer of large arteries. The process of atherosclerosis begins with the formation of fatty streaks. Fatty streaks develop in the arterial lumen in the first and second decades of life and are initially composed of lipid filled macrophages. Most often at this stage, these lesions do not narrow the arterial lumen. During the second to third decades of life some of these fatty streaks can develop into fibrous plaques, which are raised lesions with a collagen cap covering a lipid core. These lesions may obstruct normal blood flow. Also, the presence of these fibrous plaques are positively correlated with the risk of CHD and associated with its clinical complications. McGill et al (5) demonstrated that fatty streaks are present to some degree in the aortas of most children over the age of 3 years, and can also be found in the coronary arteries of children and adolescents 5-10 years later. Additionally, these researchers (5) documented that fatty streaks occupy approximately

25 % of the thoracic and abdominal aortas by the ages of 15-19 years and can increase to 40% of the abdominal aorta by the ages of 30-34 years.

Palinski and Napali (6) reported that maternal hypercholesterolemia was associated with enhanced formation of fatty streaks in human fetal arteries and accelerated development of atherosclerosis during childhood. Although physiologically the placenta is known to be impermeable to LDL particles and there is evidence that these small fetal lesions may partially regress during the end of the gestational period in infancy, there is indication that the presence of fatty streaks in these infants may influence the risk of progression to atherosclerosis later in life. In the Fate Of Early Lesions In Children (FELIC) study (7) of 156 normocholesterolemic children 1-14 years of age, progression of atherosclerosis was more rapid in the offspring of hypercholesterolemic mothers than those of normocholesterolemic mothers. Additional evidence for a role of dyslipidemia in children and adolescents in the progression of atherosclerosis into adulthood is supported by the Pathobiological Determinants of Atherosclerosis in Youth (PDAY) study (5). In this study, pathobiological examination of coronary arteries of approximately 3,000 persons, age 15-34 years, who died prematurely from accidental injury, homicide or suicide showed that the percentage of surface accumulation of fatty streaks and fibrous plaques in the coronary arteries was positively associated with LDL cholesterol concentrations. Further this study demonstrated that the third decade of life (20-24 years) is the period in the life span when elevated LDL cholesterol contributes significantly to fibrous plaque formation. Although critics of early intervention cite this later finding as one of the reasons for not intervening in childhood, the supporters of early

intervention for children and adolescents with dyslipidemia suggest that early therapeutic efforts may delay the age at which fibrous plaques start to develop (8).

Additional evidence for early intervention comes from tracking data reported in the John's Hopkins Precursor Study (1). This study tracked 1017 young men upon graduation from Johns Hopkins Medical School (average age 22 years) for a period of 27-42 years. Serum cholesterol levels were measured on multiple occasions during medical school, and averaged to obtain a single value to correlate with CHD symptoms. Serum cholesterol was strongly associated with the identification of symptoms related to CHD and CVD, as well as the total mortality and mortality due to CVD. This data suggests a strong association between the serum cholesterol level quantified in young men and CVD observed in midlife. The young men who had cholesterol levels in the upper quartile of the serum cholesterol concentrations had 5 times the incidence of CHD and 14 times the risk of cardiovascular death as compared to those in the lowest quartile. The combination of these studies and the data cited, are strongly suggestive that the atherosclerosis process has its origins in childhood.

Cholesterol Lowering Diets In Children

Potential for harm

National dietary recommendations for children above the age of 2 years have been established by several leading health organizations including the National Cholesterol Education Program (NCEP), the United States Department of Agriculture (USDA), the American Heart Association (AHA) and the American Academy of Pediatrics (AAP). These recommendations have stipulated that American children should consume a diet that contains no more than 30% of calories from fat (and no less than 20% from fat), less

than or equal to 10% of calories from saturated fat, and less than 300mg of cholesterol per day. This diet is also known as the NCEP Step I Diet. While repeated studies have been published documenting the safety and efficacy of these dietary recommendations for the pediatric population (and will be presented in the next section), Liftshitz et al (9-10) have reported several cases of failure to thrive in children following cholesterol lowering diets. Notably, these case reports were for children on parent-imposed cholesterol lowering diets. After formal nutrition counseling, the children cited in these case studies all experienced catch-up growth. Further, although nutritional inadequacies were reported among children on the parent-imposed cholesterol lowering diets, after formal nutrition counseling, dietary quality significantly improved. Importantly, the caloric intake of the children reported in these case studies was much below that recommended by national health organizations. With proper nutritional guidance all children in these reports were able to achieve a low fat dietary intake with an optimal level of calories for growth and development.

Another proponent against cholesterol lowering diets for children suggests that restricting a child's intake of fatty foods may create unhealthy attitudes toward food and eating. In a recent review paper by Olsen (11), the suggestion was made that parents who restrict unhealthy foods, such as high fat foods to lower blood cholesterol, through the use of controlling child feeding practices may in advertently increase their child's preference for these foods. Support for this suggestion comes from several studies from Birch et al (12-13-14), who demonstrated that maternal restriction of a child's access to high fat snack foods was related to over-consumption of those same foods in an unrestricted setting. Further, Birch (14) found that children whose parents were more

controlling in the amounts and types of foods they ate were less able to regulate energy intake and the amount of food consumed. Interestingly, preliminary data from Couch et al (15) found that after formal nutrition counseling, parents of children with hypercholesterolemia who restricted the availability and accessibility of high fat foods through the use of controlling child-feeding strategies actually had children who complied better with low fat dietary guidelines than children with dyslipidemia whose parents were more relaxed about their children's eating behavior. This later finding suggests that with proper guidance parents who utilize controlling child-feeding strategies may direct these efforts toward successful implementation of a heart healthy diet.

Potential Benefits and Guidelines

Several well-documented studies demonstrating the safety and efficacy of cholesterol lowering diets for children with elevated LDL cholesterol have been reported over the last decade. The landmark study, the Special Turku Coronary Risk Factor Intervention Project for children (STRIP) (16), introduced a low saturated fat and cholesterol diet to over 1,000 children before the age of one year. Follow-up was done at approximately 5-6 years. The findings from this research suggests that children can grow and develop optimally on a diet low in total fat and saturated fat when the diet is administered during and beyond infancy. Jacobson et al (17), also showed positive effects of cholesterol lowering diets administered to children in a three site New York clinic based trial. This trial involved 138 children, 2-15 years of age, diagnosed with hypercholesterolemia. Patients were advised on the NCEP Step I Diet by a registered dietitian during multiple counseling and intervention sessions over a three year period. Results showed a decrease in total cholesterol (262mg/dl to 249mg/dl) among clinic patients following the Step I

Diet. Importantly, normal growth was maintained in all subjects on the low fat diet over the three- year period.

The Child and Adolescent Trial for Cardiovascular Health (CATCH) (18), was a school based intervention program designed to lower total and saturated fat in school lunches in the diets of children. Participants included 5,106 third grade students in 56 intervention elementary schools and 40 control elementary schools. This intervention focused on health behavior changes that included both classroom activities and a home-based program aimed at helping participants meet the U.S. dietary guidelines. The program was successful in modifying the fat content of school lunches, increasing moderate to vigorous physical activity in physical education classes, and improved eating and physical activity behavior in children during the 3 year implementation phase of the project. Results also showed that these behavioral changes could be made without compromising growth and development.

The Dietary Intervention Study in Children (DISC), is considered by many to be the best controlled and longest outpatient study of hypercholesterolemia in children (19). The study followed 663 hypercholesterolemic children who were approximately 8-10 years of age for a period of three years. All children had LDL cholesterol concentrations in the 80^{th} to the 98^{th} percentile range. This multi-center diet intervention trial provided children with an intensive behavioral focused nutrition intervention program designed to assist children in modifying their dietary fat intake to a level of 28% of energy from total fat, < 8% energy from saturated fat, up to 9% of energy from polyunsaturated fat, and intake of dietary cholesterol not to exceed 150mg per day. The control group received minimal dietary intervention. After three years the experimental group experienced a

greater reduction in LDL cholesterol as compared to the control group, while adequate growth was maintained. In total these studies support the use of diets low in total and saturated fat to lower elevated LDL cholesterol levels and to maintain normal growth and development in children.

Guidelines for implementing a cholesterol lowering diet

As more and more research accumulates on the benefits of low fat diets for the treatment of dyslipidemia in children, the need for screening and intervention guidelines has moved forward. The NCEP together with the AHA has developed screening guidelines (see Table 1) along with suggested intervention guidelines and strategies to lower fat in the diets of children and adolescents.

Table 1. National Cholesterol Education Program Classification of Total and LDL Cholesterol Levels in Children and Adolescents

Category	Total Cholesterol	LDL Cholesterol
Acceptable	<170 mg/dl (4.4mmol/L)	<110mg/dl (2.85mmol/L)
Borderline	170 – 199mg/dl (5.15mmol/L)	110 – 129mg/dl (3.35mmol/L)
High	>200 mg/dl (5.20mmol/L)	>130mg/dl (3.40mmol /L)

These organizations recommend selective screening of children age 2 or above based on specific criteria including a parent with a total cholesterol $\geq$240mg/ dl or LDL cholesterol $\geq$130mg/dl or the early onset of CHD in a parent or grandparent before the age of 55. Criticism of these guidelines by health professionals stems from the fact that approximately 50% of children with elevated LDL cholesterol do not have a parent with either of these qualifying criteria (20). Lifestyle habits and conditions that significantly contribute to a higher risk of dyslipidemia in children and adolescents consist of smoking, decreased physical activity and overweight/obesity (21). Additionally certain underlying

diseases such as liver disease, diabetes and hyperthyroidism are known to cause dyslipidemia. With all of these factors in mind some experts in the field are suggesting universal screening rather than the approach currently being utilized.

The NCEP and AHA have a similar position on the recommended diet for lowering elevated LDL cholesterol levels in children and adolescents. The AAP, the Centers for Disease Control (CDC), the USDA, and the National Institute for Health offer complimentary guidelines as well (see Table 2).

Table 2. Summary and Comparison of Dietary Fat and Cholesterol Guidelines from Major U.S. Health Organizations for Children over 2 Years of Age

Organization, Year of Guideline Referenced	Guideline for Childhood Dietary Intake of Fat and Cholesterol	Notes on Differences Between Guidelines
American Academy of Pediatrics, Committee on Nutrition: Statement on Cholesterol, 1992	Recommends an average daily intake of ≤30%Kcal from total fat (but more than 20% Kcal); <10%Kcal from saturated fat, and ,< 300 mg of cholesterol/per day with gradual adoption of guidelines between 2-5 years of age.	Sets minimum level of dietary fat intake at 20%. Recommends transition period for children < 5 years of age.
Healthy People 2000 & Healthy People 2010; National Health Promotion & Disease Prevention Objectives, 1991/2001	Objective 2:5/Obj. 19.8,19.9; Reduce dietary fat intake to an average of 30% of energy or less and average saturated fat intake to < 10% of energy among people 2 years and older.	No transition period.
American Heart Association, Council on Cardiovascular Disease in the Young: 1991, 1983	Recommends total fat intake at ≤ 30%Kcal saturated fat < 10% Kcal; and cholesterol intake < 300mg.	No transition period.
United States Department of Agriculture; U.S. Dept. of Health and Human Services; Dietary Guidelines for Americans, 4th edition. 1995	Recommends an average daily intake of ≤ 30% Kcal from total fat, < 10% Kcal from saturated fat , and < 300 mg of cholesterol per day , with transition period between 2 – 5 years of age.	Transition period for children 2 to 5 years of age.
National Cholesterol Education Panel: Report of the Expert Panel on Blood Cholesterol Levels in Children & Adolescents, 1992.	Recommends total fat intake at ≤ 30% Kcal, saturated fat <10% Kcal; and cholesterol intake < 300 mg/day. Transition period for children 2-3 years old.	Transition period for children 2 to 3 years old.
National Institutes of Health Consensus Development Panel 1985	Recommended total fat intake at ≤ 30% Kcal, and saturated fat < 10% Kcal for all Americans over 2 years of age.	No transition period.

Modified from Reference (22).

In general these agencies recommend that children and adolescents with elevated LDL cholesterol follow the NCEP Step I Diet for a period of 3 months. After this time, a follow-up fasting blood sample should be drawn to check for lipid profile response. If the LDL cholesterol remains elevated the NCEP Step II Diet should be initiated. The Step II Diet consists of the following: $\leq$30% of total calories from fat, < 7% of the total calories from saturated fat and < 200mg of cholesterol per day. If repeated attempts at diet treatment for at least 6 months to one year do not bring about a desired LDL cholesterol level the NCEP recommends the use of medication only for adolescents > 10 years of age. Professionals should assess the patient's compliance to and acceptance of the Step I and II Diets before making any further dietary changes or initiating drug therapy.

Making dietary changes to meet Step I diet

Several reports have reviewed the evidence documenting the efficacy of the NCEP Step I and Step II Diets in lowering elevated lipids and that nutritional adequacy can be maintained while following these lipid-lowering diets (2-3). Additionally, the Framingham Heart Study has shown that healthy eating habits developed during childhood track into adulthood (23). Specifically a significant proportion of children in the Framingham cohort who consumed a low saturated fat, low cholesterol diet in childhood were those that consumed a low saturated fat, low cholesterol diet as adults. This finding suggests that early intervention to promote the development of heart healthy eating habits in childhood may prevent the development of unhealthy eating habits and related physiological complications with age.

It should be noted that changing the dietary behavior of children and adolescents may be a challenge. As recent nutritional surveys have shown, the dietary intakes of children and adolescents are often inadequate when compared to national guidelines. In particular, children and adolescents consume excessive amounts of fat (particularly saturated fat), and inadequate amounts of fruits and vegetables. Data from the 1989-1991 Continuing Survey of Food Intakes of Individuals (CFSII) found that among children and adolescents, only one third met the goal for saturated fat (<10% of total calories) (24). Further only 1% of adolescents surveyed met all the dietary guidelines for their age group. Clearly, designing a successful nutrition intervention program for youth requires knowledge of the determinants of dietary behavior of this age group with efficacious strategies for change. Before successful strategies can be developed, nutrition educators need to be knowledgeable of which dietary changes are the most feasible and which will have the greatest impact on lowering dietary saturated fat and cholesterol, and ultimately in lowering lower serum cholesterol among children and adolescents.

In an effort to address this question, Basch et al (25) analyzed diets of children in an urban setting who met the NCEP guidelines for total fat, saturated fat and cholesterol. These researchers found that the single dietary change of switching from whole milk to 1% milk resulted in two thirds of the children meeting the NCEP guidelines. Dixon et al (26) tracked changes in diets of 303 children, ages 4-10 years living in a rural setting, over a three- month period to determine what dietary changes were made when dietary fat intake was reduced. In this study, children who had the most significant reduction in total dietary fat did so by reducing the number of servings from meat, eggs, dairy, fat/oils and breads, and increasing the number of servings consumed from fruits, vegetables and

desserts. It was also noted that children who were able to significantly reduce total dietary fat consumed more low fat choices within these same food groups.

Several interesting questions arise from the results of the studies sited above. First, would children/adolescents diagnosed with hypercholesterolemia make the same dietary changes as reported by Basch et al (25) and Dixon et al (26) in response to a dietary intervention focusing on the Step I Diet? Second, would children in an urban setting make similar dietary changes as those reported by Basch and Dixon and their colleagues whose population samples were from a rural setting? Third, would dietary saturated fat reductions result in the same food group modification as reported in previous studies? Knowledge of food group modifications that result in significant decreases in total and saturated fat would be valuable for use in designing appropriate intervention methods, materials and treatment programs to meet the needs of children diagnosed with hypercholesterolemia.

Specific Aims and Research Hypothesis:

This study will assess which foods and food groups are modified in the diets of children diagnosed with hypercholesterolemia when they change their saturated fat intake after 3 months of participating in a clinic-based nutrition intervention program focusing on adherence to the NCEP Step I Diet.

The major hypothesis of this study is that children with hypercholesterolemia who lower their intake of dietary saturated fat after 3 months of participating in a clinic based nutrition intervention program focusing on the Step I Diet will have a greater reduction in their intake of high fat foods and a greater increase in their intake of low fat foods from

all food groups included within the Food Guide Pyramid as compared to children from the same population who do not lower their intake of saturated fat.

Methods

Subjects

The Cholesterol Treatment Center (CTC), located in Children's Hospital at the University of Cincinnati Medical Center, maintains a referral program for the diagnosis and treatment of children with hypercholesterolemia. Children are referred to the CTC following initial diagnosis by their primary care physician. Subjects for the study were recruited from this population. Children were excluded from the study if the cause of their hyperlipidemia was secondary to other diseases, they had homozygous low-density lipoprotein (LDL) receptor deficiency (cholesterol level > 400mg/dl) or if they were currently taking any cholesterol lowering medications. These individuals were excluded because the potential for effective dietary treatment varies as compared with children with uncomplicated hypercholesterolemia. This study was conducted as part of a larger project that was funded by the American Heart Association, Ohio Valley Affiliate.

Study Protocol

Children and families newly referred with a scheduled appointment at the CTC were contacted via phone or letter and asked to take part in this study. Those children and families agreeing to participate in the study met with a registered dietitian approximately one week prior to their scheduled visit. At this time families were given an explanation, and instructional materials on how to complete a 3-day food record. They were also given a 2-dimensional portion size sheet for use in estimating the quantity of foods eaten

during this recording period. Subjects and families were asked to bring the completed food records to their initial CTC appointment At the initial visit a registered dietitian reviewed the records with them. Close attention was given to portion sizes, brand names, type of preparation and combination dishes etc. As part of routine care at the CTC, subjects were given a routine physical examination by the center cardiologist. The visit also consisted of height, weight, blood pressure, skin-fold measurements and collection of a detailed medical history. Upon completion of the physical exam each family and subject met again with the registered dietitian. At this time the registered dietitian counseled and advised them on the NCEP Step I guidelines used for treatment of hypercholesterolemia. During this counseling session printed material, which had been developed by the CTC, was used and given to the subjects and families. This material titled " Eating for a Healthy Heart" provides specific information regarding the implementation of the Step I Diet. It includes definitions, a list of foods to avoid and include, tips on recognizing and purchasing lower fat foods, low fat methods of preparation and heart healthy recipes. Approximately 3-months after the initial visit, subjects and families were asked to return to the CTC. Prior to this visit, subjects and families were sent a 3-day food record form, instructions and the 2-dimensional portion size food model sheet identical to the ones used at the initial visit. At this 3-month visit, subjects and families followed the same procedure as during the initial visit. They also met with the registered dietitian, who reviewed the completed forms and collected them at this time.

Dietary Assessment Methods

3-day food record

At the initial and 3-month clinic visits, completed 3-day food records were collected from each subject/family. Each subject/family had been instructed by a registered dietitian on how to complete the food records. Subjects who were younger than 8 years of age were asked to have a parent complete the record with assistance from the child. Those children who were older than 8 years were asked to complete the food record, with parental assistance. To assist with quantity of foods eaten, subjects were given and instructed on use of a 2-dimensional portion size food model sheet. All 3-day food records were reviewed by the registered dietitian in a face- to- face setting. At that time they were checked for adequate information, clarity of food descriptions, amounts consumed and method of preparation.

The Minnesota Nutrient Data System (NDS, version 2.92) was used to analyze all foods consumed for nutrient composition. Although detailed nutrient profiles for all food records were compiled, this study will report only on caloric and saturated fat intake. For the purpose of statistical analysis, the subjects were classified into two groups based on change in average daily saturated fat over a 3- month period.

Food group intakes

The methodology developed by Dixon et al (26) was used to group foods in this study. This method involved assigning all foods reported into one of 10 food groups, according to NCEP guidelines for children. The 10 food groups were meats, eggs, dairy products, fats/oils, breads/starches, vegetables, fruits, desserts, beverages, and gravy/sauces. Our

study collapsed the 10 food groups into 8, combining the beverages into either the fruit group for 100% fruit juice items, or desserts for fruit punches and sodas. Items which could be considered gravies were included in the fat / oils group. From each child's food record the number of servings from each food group consumed was calculated. Food items eaten within each food group were then subdivided based on total fat content/serving. These "fat" subgroups were low fat foods (less then 3.0 grams/serving), moderate fat (3.0 to 5.0 grams/serving) and high fat (greater than 5.0 grams/serving) (26). Foods were categorized into the groups based on fat content in one standard serving of the food as referenced in Bowes and Church 17th edition (27).

Table 1. Guidelines for representative foods within 8 main food groups.

Meats – Beef, Lamb, Pork, Veal, Game, Cold Cuts, Organ Meats, Poultry, Fish, Peanut Butter, Meat Substitutes	**Fats & Oils** – Animal Fats, Shortenings, Margarine, Oils, Salad Dressings, Nuts, Seeds, Olives, Avocados, Gravies	**Dairy** – Milk, Cream, Yogurts, Cottage Cheese, Cream Cheese, Hard Cheeses, Frozen Dairy Desserts, Baby Formula, Imitation Dairy Products
Eggs – Whole Eggs, Egg Whites, Egg Substitutes.	**Fruits** – Fresh , Frozen, Canned Fruits, Dried Fruits, Fruit Juices, Fruit Salads	**Vegetables** – Fresh, Frozen, Canned Vegetables, Vegetable Juices, Salads
Starches & Breads – Yeast Breads, Baked Breads, Buns Rolls, Flour/Grains, Cereals, Pastas, Rice, Dried Beans and Peas, Legumes, Soy Products Crackers, Snacks and Chips, Soups, Pizza Crust, Pop Tarts, Doughnuts, Breakfast-Bars	**Desserts** - Cookies, Cakes, Pies, Jello, Frozen Non Dairy Novelties, Sugars, Syrups, Jellies, Frostings, Toppings, Candy Bars, Hard Candies, Regular Sweetened Sodas, Fruit "Drink" Beverages	

Table 2. NCEP Serving Sizes

Meats, Poultry, Fish (lean, well trimmed, no skin)	Cooked Meats, Medium Chops, Patties, Diced Meats or Chicken, Half Chicken Breast, Chicken Leg-Thigh Flaked fish Peanut butter	3 ounces or ¾ cup 2 Tbsp.
Dairy Products (skim, non-fat or low fat)	Milk, Yogurt Cheeses Cottage cheese Frozen Dairy Desserts	8 ounces (1 cup) 1 oz. ½ cup ½ cup
Eggs	Eggs whole Egg white or Substitute	1 ¼ cup or 1
Fats and Oils	Unsaturated oils, Margarines Salad dressings, Seeds, Nuts Olives Avocado	1 tsp. 1 Tbsp. 5 small 1/8 whole
Breads and Cereals	Bread Hamburger /Hot Dog Bun Corn Tortilla Cold Cereal Bran Cereal Cooked Cereal Pasta, Rice, Dried Beans Animal Crackers Graham Crackers Saltine Crackers Biscuit, Corn Bread, Muffins(2") Quick Breads Pancakes (4") Waffles (9') Soup Starchy Vegetables	1 slice ½ 1 1 cup 1/3 cup ½ cup ½ cup 8 3 6 1 1 slice 1 ¼ 1 cup ½ cup
Vegetables	Other Vegetables fresh, frozen, raw, or cooked. Veg Juices	½ cup
Fruits	Fruit, (fresh , frozen, canned) Fruit Juice	1 medium piece or ½ cup ½ cup
Sweets and Desserts	Fruit Flavored Beverages, Lemonade, Fruit Punch Sugar, Syrup, Honey Jam , Jelly Candy Corn, Hard Candy, Drops Flavored Gelatin Frozen desserts Cookies Cake Pie Angel Food Cake	6 oz. 1 ½ Tbsp. ¾ oz. ½ cup ½ cup 2 1 slice (1/12 of 2 layer or 1/20 of 9x13) 1/8 of 9" pie 1/12 of cake

Table 3. NCEP recommended number of servings/day for 4-10 year old children from food groups.

Lean Meats, Poultry, Fish	5-6 ounces/day
Eggs	3-4 x per week
Dairy (low or non fat selections)	3-4 servings/day
Fats and Oils	7 servings/day
Vegetables	3 or more servings/day
Fruits	3 or more servings/day
Desserts	2 servings/day with reduced fat content
Breads/ Starches	6 or more servings per day

Data Analysis

For statistical analysis, subjects were divided into two groups based on change in saturated fat intake over 3 months: Group I were those who reduced their intake of saturated fat and Group II were those that did not reduce their intake of saturated fat after 3 months of participation in a clinic based dietary intervention program emphasizing the Step I diet. Demographic characteristics, number of servings consumed from the different food groups and servings from different fat subgroups pre and post intervention and change in number of servings consumed from the different food groups and different subgroups after 3 months of diet instruction, were compared between the two subject groups using a t-test with a p value of < 0.05 denoting statistical significance.

Results

This study was completed by 47 children/adolescents. Table 4 provides an overview of the study population demographics. Table 4 shows that the children in Group I who reduced their intake of saturated fat versus those children in Group II who did not reduce their intake of saturated fat after 3 months of dietary counseling were similar for age, BMI and ethnicity.

Table 4. Baseline demographics of study population: A comparison of children who reduced percent of calories from saturated fat (Group I) versus children who did not reduce percent of calories from saturated fat (Group II)

Demographic Characteristics	Group I – Children Who Reduced Their Percent Calories From Saturated Fat n = 23	Group II – Children Who Did Not Reduce Their Calories From Saturated Fat n = 24
Age (y) mean +/- SD	9.18 +/- 2.64	10.51 +/- 3.15
BMI (kg/m2) mean +/- SD	21.50 +/- 5.61	21.67 +/- 6.22
Gender = n		
males	12	9
females	11	15
Ethnic origin = n		
Black	4 (8.51%)	0 (0%)
White	19 (40.43%)	23 (48.94%)
Other	0	1 (2.13%)

A comparison of Group I versus Group II for change in calories and saturated fat intake after 3 months of dietary instruction is shown in Table 5. The children in Group I decreased their mean total caloric intake by approximately 185 kcal/day from baseline to 3 months, while mean caloric intake of the children in Group II stayed relatively constant. The baseline and 3-month intake of percent of calories from saturated fat consumed by children in Group I decreased from a mean of 11.15% at baseline to 8.54 % at the 3-month time frame, thus showing an overall mean percent decrease of 2.61%. In contrast children in Group II showed an increase in their mean percentage of saturated fat from 9.29% to 11.51 %. This reflects a mean percent increase of 2.21%.

Table 5. Baseline and 3-month intake of total calories and percent of calories from saturated fat consumed by children: A comparison of children who reduced percent calories from saturated fat (Group I) versus children who did not reduce percentage calories from saturated fat (Group II).

	Group I	Group I	Group II	Group II
Time Period	**% kcal from saturated fat n=23**	**kcal n=23**	**% kcal from saturated fat n=24**	**kcal n=24**
Baseline	11.15 +/- 2.37	1590.74 +/- 323.51	9.29 +/- 2.30	1501.93 +/- 419.51
3 Months	8.54 +/- 2.00	1405.06 +/- 343.68	11.51 +/- 2.74	1508.81 +/- 339.83
% Change	-2.61 +/- 1.65	-185.73 +/- 27.62	+ 2.21 +/- 2.12	+ 6.68 +/- 159.57

- baseline food data obtained prior to the initial visit at the Cincinnati Children's Hospital CTC

As shown in Table 6, children who reduced their intake of saturated fat (Group I), consumed significantly less high fat dairy servings at 3 months as compared to children who did not change their intake of saturated fat. Group I also showed a trend ($p < .10$) for lower intake of servings from the medium fat meats, eggs and medium fat /oils group. Overall children who changed their intake of saturated fat did so mostly by decreasing their intake of foods from the dairy, meats, fat /oils and egg groups.

Table 6. Baseline and 3-month mean (+/- SD) number of servings from 8 main food groups and subgroups by: children who reduced percent of calories from saturated fat (Group I) versus children who did not reduce percentage of calories from saturated fat (Group II).

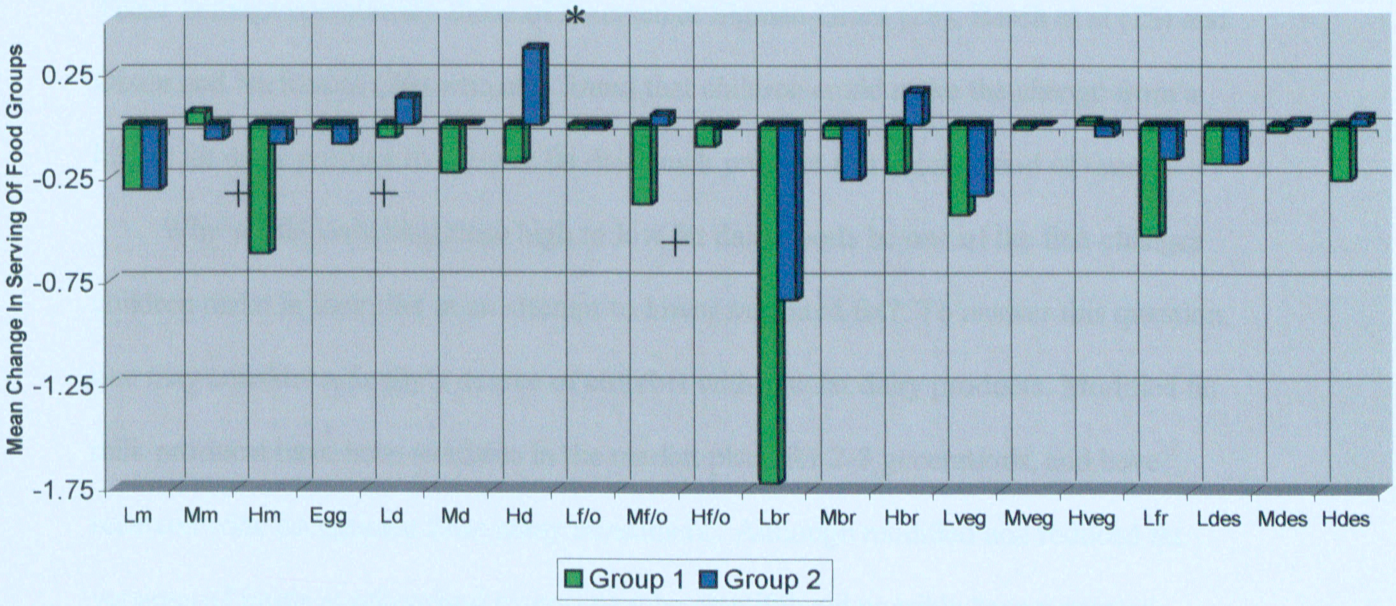
Main Food Groups /Subgroups	Group I n=23	Group II n=24	Group I n=23	Group II n=24
	Baseline	Baseline	3-Month	3-Month
Meats – Low Fat	0.51 +/- 0.81	0.49 +/- 0.75	0.20 +/- 0.69	0.18 +/- 0.59
Med Fat	0.26 +/- 0.57	0.13 +/- 0.30	0.32 +/- 0.68	0.45 +/- 0.23+
High Fat	1.32 +/- 1.58	1.24 +/- 1.37	0.70 +/- 1.34	1.15 +/- 1.56
Eggs - Whole	0.02 +/- 0.10	0.14 +/- 0.27	0	0.16 +/- 0.18+
Dairy – Low Fat	0.56 +/- 0.72	0.43 +/- 0.67	0.50 +/- 0.89	0.56 +/- 0.88
Med Fat	0.31 +/- 0.47	0.24 +/- 0.42	0.08 +/- 0.23	0.25 +/- 0.48
High Fat	0.50 +/- 0.61	0.27 +/- 0.35	0.31 +/- 052	0.64 +/- 0.79*
Fats – Low Fat	0.04 +/- 0.11	0.06 +/- 0.18	0.02 +/- 0.10	0.04 +/- 0.14
Med Fat	0.41 +/- 0.85	0.22 +/- 0.38	0.03 +/- 0.14	0.26 +/- 0.62+
High Fat	0.23 +/- 0.60	0.11 +/- 0.19	0.13 +/- 0.46	0.10 +/- 0.31
Starches -				
Low Fat	3.04 +/- 2.73	2.50 +/- 2.54	1.32 +/- 2.16	1.67 +/- 2.03
Med Fat	0.38 +/- 0.56	0.37 +/- 0.60	0.32 +/- 0.63	0.12 +/- 0.30
High Fat	0.61 +/- 0.84	0.53 +/- 0.95	0.38 +/- 0.68	0.70 +/- 1.05
Vegetables –				
Low Fat	0.69 +/- 0.78	0.60 +/- 0.71	0.26 +/- 0.47	0.26 +/- 0.44
Med Fat	0.01 +/- 0.05	0	0	0
High Fat	0	0.08 +/- 0.26	0.02 +/- 0.06	0.03 +/- 0.14
Fruits – Low Fat	0.77 +/- 1.05	0.67 +/- 0.86	0.23 +/- 0.45	0.51 +/- 0.92
Desserts –				
Low Fat	1.01 +/- 1.15	1.23 +/- 1.94	0.83 +/- 1.33	1.05 +/- 1.55
Med Fat	0.06 +/- 0.17	0	0.04 +/- 0,14	0.02 +/- 0.07
High Fat	0.60 +/- 0.78	0.33 +/- 0.52	0.34 +/- 0.64	0.38 +/- 0.84

* indicates statistical significant difference between groups ($p < 0.05$)

\+ indicates observed significant trends between groups ($p < 0.10$)

Figure 1 compares Group I and Group II for the mean change in number of servings consumed for low, medium and high fat servings from 8 food groups after 3 months of formal nutritional counseling. Groups differed significantly for change in intake of high fat dairy foods. There was also a trend ($p < .10$) for difference between groups in change of number of servings of medium fat meats, eggs and medium fat- fat /oils.

FIG. 1 - MEAN CHANGES AFTER 3 MONTHS IN NUMBER OF LOW, MEDIUM, HIGH FAT SERVINGS FROM 8 FOOD GROUPS IN THE DIETS OF CHILDREN



*** indicates statistical significant differences between Group I & II for change in intake from food groups ($p < 0.05$)**

\+ indicates observed significant trend for difference between Group I & II for change in intake from food groups ($p < 0.10$)

LM=low fat meat, MM= medium fat meat, HM= high fat meat, LD= low fat dairy, MD= medium fat dairy, HD= high fat dairy, LF/O= low fat fat/oils, MF/O= medium fat fat/oils, HF/O= high fat fat/oils, LBR= low fat bread/starch, MBR= medium fat bread/starch, HBR= high fat bread/starch, LVEG= low fat vegetable, MVEG= medium fat vegetable, HVEG= high fat vegetable, LFR= low fat fruit, LDES= low fat dessert, MDES= medium fat dessert, HDES= high fat dessert

Discussion

This research project was conducted to determine what changes are made in the diets of children diagnosed with hypercholesterolemia following formal nutritional counseling on the NCEP Step I Diet. Since nutritional therapy is the foundation for treatment of children with hypercholesterolemia, understanding and determining what dietary modifications are feasible for children to make to lower their saturated fat intake would be especially helpful information for dietitians to use in working with this population. This project was based in part on a similar study conducted by Dixon & McKenzie (26).

Results from our study showed that a significant number of these children lowered their dietary saturated fat intake by reducing their consumption of high fat milk/dairy products. These findings corroborate those of Petersen & Sigman-Grant (28), Basch et al (25) and Dixon and McKenzie (26) who also found that children could make the change from a higher fat dairy product to a lower fat dairy/milk product in a short period of time.

Why would switching from high to low fat dairy foods be one of the first changes children make in their diet in an attempt to lower saturated fat? To answer this question, one may consider a family's degree of comfort with low fat dairy products. Modified fat milk products have been available in the market place for 2-3 generations, and have received wide acceptance from many consumers. Although modified and reduced fat versions of foods in other food groups may be plentiful and possibly have a greater appeal than when first introduced into the market place in the early 1990's, they are still not as widely accepted and universally used as reduced fat dairy selections. The ADA Position Paper on Dietary Guidance for Healthy Children 2-11 years of Age (29) reports that during the period between 1977-1994 the proportion of children drinking non-fat or reduced fat milk had doubled. Therefore the increased availability and accessibility of these non-fat and low-fat dairy products in homes would provide routine opportunities for children to use and accept them at an early age. Research also shows that with repeated exposures to a food (minimum 8-10 exposures), children will develop an increased preference for that food (29).

Our findings also revealed that following nutritional counseling, the children who lowered their saturated fat intake did so by reducing their mean number of servings of high-fat or moderate fat choices within a food group while not increasing their intake of

low fat choices within the same or other food groups. This was notable in the high fat dairy group, but was also apparent in the meats, fat/oils, and breads/starches food groups. While foods within these groups contribute substantial amounts of total fat and saturated fat to a child's diet, they also contribute calories and essential nutrients to a child's diet. This is evidenced by the fact that when Group I in our study significantly decreased their intake of high fat dairy foods, as well as high fat foods from other food groups, they reduced their caloric intake by 12%. The calorie intake of Group II remained unchanged. This finding highlights the need for nutrition professionals to emphasize that when children attempt to decrease their intake of high fat foods, calories should be made up through appropriate selections among lower fat foods choices in the same or other food groups. Important studies have shown that as children age, the contribution of dairy products to their total calorie and fat intake goes down relative to calories and fat consumption from other food groups (29). Thus formal nutrition counseling for children with hypercholesterolemia should encourage the reduction of saturated fat from all food groups contributing this nutrient to the diet, namely meats, fats/oils and breads and starches, as well as promote consumption of adequate calories and nutrients to maintain optimal growth and development.

Although our study corroborates previous findings demonstrating that children choose to lower high fat dairy products as the first means of modifying dietary saturated fat, the small sample size of this study may have reduced our ability to denote significant changes within other food groups. None the less our data suggests switching from high to low fat dairy foods is an effective dietary strategy to enable 4-10 year old children to lower their intake of saturated fat. This information should be utilized by dietitians in

clinical practice, when assisting children and their families in making selections to translate the NCEP guidelines into feasible and effective daily dietary choices. This study supports findings that dietary changes to lower saturated fat intake in children can be simple, accomplished in a short period of time and acceptable to young children.

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