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Abstract

The purpose of this study was to determine how children with hypercholesterolemia changed their diet to meet the National Cholesterol Education Program's recommendation for dietary saturated fat. Three-day food records were collected and analyzed for numbers of servings from different food groups based on total fat content at baseline and 1 year after nutritional counseling on the Step-One Diet. Children were divided into two groups for statistical analyses: those who lowered vs. those who did not lower or increased saturated fat intake. Children who lowered their saturated fat intake did so primarily by switching from high fat dairy products to lower fat versions of these products. Nutrition professionals may want to emphasize changes within the dairy group as an effective means of enabling children to lower their saturated fat intake. This dietary change may, in turn, help the children lower their serum cholesterol levels.

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Introduction

Cholesterol is an integral component of cell membranes, particularly those membranes comprising nerve tissue. Cholesterol also serves as a building block for important steroids in the body, including steroid hormones, bile acids, and vitamin D. Humans maintain a supply of cholesterol in two ways. The body, mainly the liver, produces approximately 1000mg/day of cholesterol; another 400-500mg/day is from the diet. Foods from animals (especially egg yolk, meat, poultry, fish, sea food, and whole dairy products) contain cholesterol. Foods from plants (fruits, vegetables, nuts, grains, and seeds) do not contain cholesterol. Typically, the body makes all the cholesterol it needs.

Cholesterol is transported into and out of cells by lipoprotein carriers. While all lipoproteins transport cholesterol, those that are more cholesterol dense include low density lipoproteins (LDL) and high density lipoproteins (HDL). High levels of serum HDL have a protective effect against Coronary Heart Disease (CHD), while low levels (<40mg/dL) increase risk for CHD. A borderline or high level of LDL-cholesterol (C) (>130mg/dL) is associated with an increased risk for CHD, whereas, a low level of LDL-C is associated with a lower risk. Excessive LDL-C contributes to plaque formation in major arteries, a prelude to CHD. It is believed that HDL-C absorbs cholesterol crystals as they are deposited along arterial walls, thereby preventing plaque formation. Consequently, a high ratio of HDL-C to LDL-C is associated with a reduced risk for CHD. Although CHD typically presents in adulthood, the damage to the arteries is chronic in nature. Atherosclerotic lesion formation and progression often develop without overt symptoms over many decades. For children diagnosed with

hypercholesterolemia, the possibility of longer exposure and more adverse effects of high serum cholesterol levels should be considered in managing their dyslipidemia.

Literature Review

Clinical manifestations of atherosclerosis usually occur during middle-age, however, early signs of atherosclerosis can be traced to childhood (Nicklas, von Duvillard, & Berenson, 2002). Clear evidence is available that tracking of some CVD risk factors in childhood exists; in particular, children with elevated total and LDL-C levels tend to have elevated levels in adulthood (Nicklas et al. 2002). Pathological studies have long noted that atheromatous plaques contain significant amounts of cholesterol and identified LDL-C as the main atherogenic lipid particle (Starc, 2001). Over time, the atheratoma mature, increase in size, and may predispose the individual to a clinical event such as a myocardial infarction.

The Pathobiological Determinants of Atherosclerosis in Youth (PDAY) study was a unique research program initiated in 1985 to document the natural history of atherosclerosis and to determine, postmortem, the relation of cardiovascular risk factors to atherosclerosis in young subjects (Pathobiological Determinants of Atherosclerosis in Youth (PDAY) Research Group, 1993). Coronary arteries, aortas, and other tissues were examined from more than 3,000 subjects age 15 to 34 years who died of external causes. The study documented the fact that by age 15 most teenagers had developed fatty streaks in some part of their arterial system. There was a wide variation in the age at which intermediate lesions (fatty plaques) developed in both the aorta and coronary artery, and this variation was directly related to the cardiovascular risk factors that were quantitatively measured (Wissler & Strong, 1998). Further investigation of data from

gross and microscopic evaluation of aorta and coronary arterial specimens as part of the PDAY study showed that the association of lipoprotein risk factors with intermediate type atherosclerotic lesions became evident in subjects in their late teens, whereas associations with raised lesions became evident in subjects 25 years of age and older (Strong, Zieske, & Malcolm, 2001). Therefore, the PDAY study strongly suggest that atherosclerosis has its origins in childhood, showed that progression toward clinically significant lesions may occur in young adulthood, and demonstrated that the progression of atherosclerosis is strongly influenced by coronary heart disease risk factors. The findings of PDAY emphasized the need to modify risk factors (particularly elevated serum cholesterol) in childhood as a primary, long-range preventative strategy against coronary heart disease.

Numerous studies have shown that dietary saturated fat is associated with elevated serum cholesterol concentration and, consequently, increased formation of atherosclerotic lesions (Nicklas, et al. 2002; Strong, et al. 1991; Starc, 2001). Diets low in total fat, saturated fat, and cholesterol have been shown to lower LDL-C levels in adults (Mensink & Katan, 1992; American Academy of Pediatrics. Committee on Nutrition, 1998)) and several studies have shown this same effect in children (Shannon, Tershakovec, & Martel, 1994; Key & Rocchini, 1991; Starc, 2001)). The DISC study evaluated the efficacy and safety of lowering dietary intake of total fat, saturated fat, and cholesterol to decrease LDL-C levels in children (The Writing Group for the DISC Collaborative Research Group, 1995). At the time of this study there was no prior research addressing the long-term growth and development of children on low fat and low cholesterol diets. DISC was an ongoing six-center randomized controlled trial.

Subjects were prepubertal boys and girls aged 8-10 years with elevated LDL-C levels. A behavioral component was included consisting of intervention strategies based on social learning theory and social action theory to promote adherence to the diet plan. The primary efficacy measure was change in dietary fat intake and LDL-C level at 3 years. Secondary safety outcomes were zinc, vitamin A, and protein status, and change in HDL-C and triglycerides. The intervention group decreased total and saturated fat intake at 1 and 3 years, while the control group maintained baseline fat intake. At three years, the intervention group had significantly lower mean serum LDL-C concentrations than the control group. Thus, the DISC study demonstrated that low fat diets can be adequate for growth while effectively lowering serum cholesterol (Starc, 2001). Additional studies in young children and adolescents have shown that cholesterol-lowering diets do not impair growth and development when adequate calories and nutrients are provided (Shamir & Fisher, 2000; Obarzanek, et al. 1997; Shannon, et al. 1994). In a review paper by Couch, Daniels, and Deckelbaum (2002), it was noted that results from the DISC study have been corroborated by other clinic-based studies (Jacobson, et al. 1998; Kuehl, et al. 1993; Tershakovec, et al., 1998)

Given the strength of the evidence for a serum cholesterol lowering effect of a low fat diet, the National Cholesterol Education Program (NCEP) recommends reducing dietary fat and cholesterol as the primary strategy to lower elevated blood LDL-C levels in children and adolescents to prevent atherosclerosis and subsequent Cardiovascular Disease (CVD) (Expert Panel on Blood Cholesterol Levels in Children and Adolescents, 1992). Specifically, the NCEP recommends a step-wise approach to lowering these dietary components. The first step advocated by this organization is a diet that contains

less than or equal to 30% of calories from fat, less than 10% of calories from saturated fat, and a cholesterol intake limited to < 300 mg/day (Starc, 2001; Shamir & Fisher, 2000). The second step in the dietary progression is lowering saturated fat intake to < 7% of total calories and cholesterol to less than 200 mg/day.

While short-term studies have shown that children can achieve the recommended fat and cholesterol intake goals designated by the NCEP, long-term studies have demonstrated a reduction in compliance over time (Dixon, McKenzie, Mitchell, Shannon, and Smiciklas-Wright, 1996). Reasons for poor compliance to the diet are unclear. However, literature in the child feeding behavior area has suggested that children prefer foods that are high in fat and sugar. Thus, it is not surprising that maintaining adherence to a dietary plan to lower total and saturated fat intake may pose a particular challenge to both patient and family. To improve dietary compliance to a heart healthy diet, Birch and Fisher (1998) suggest increasing children's exposure to low fat foods. In support of this strategy, these researchers demonstrated that repeated exposure to foods low in fat and cholesterol increased children's acceptance of these foods. At a concrete level, this suggests that after repeated exposure, for example, to a low fat diet plan, children will learn to accept the taste of low fat foods, vegetables, and other healthful foods leading to adherence to a diet plan. The implication is that increased exposure to "heart healthy foods" may foster compliance and hopefully adherence to a low fat diet into adulthood, when CHD is manifested. The importance of the parent in promoting heart healthy eating habits is highlighted by Couch, et al. (2002). These authors review strategies that parents can use to promote acceptance of low fat foods including increasing the

accessibility and availability of healthful foods, modeling healthy food habits, and presenting heart healthy foods to a child in a relaxed non-pressured manner.

Dietary intervention programs that incorporate behavior change strategies often report more positive dietary outcomes as compared to those that don't. The Dietary Intervention Study in Children (DISC) used behavioral change strategies to promote adherence to the NCEP Step 1 Diet over a 3-year period. This intervention resulted in a significant reduction in dietary total fat, saturated fat, and cholesterol, as well as a modest lowering of LDL-C while maintaining adequate growth and nutritional adequacy in children (The Writing Group for the DISC Collaborative Research Group, 1995). Other studies reported similar findings. In a home-based dietary intervention study, Shannon et al. (1994) compared two educational approaches for administering the Step-One Diet to children. One was a parent-child autotutorial program (PCAT) and the other was standard nutritional counseling by a registered dietician . Children were randomly assigned to one of the two intervention groups (PCAT or standard nutritional counseling) or to an "at risk" control group. It was reported that mean grams of total and saturated fat consumed by both the parent-child autotutorial (PCAT) and nutritional counseling groups declined, while fat intake of the at-risk control group increased slightly; at the 3-month follow-up, these differences were significant ($P < .05$). At the one year follow-up of this same study, similar findings were recorded (Tershakovec, et al., 1998). A case comparison study conducted in New York City also concluded that nutrition education and counseling for a heart-healthy diet based on the NCEP Step One diet is an integral part of the management of pediatric hyperlipidemia (Copperman, Schebendach, Arden, & Jacobsen, 1995). Children with hyperlipidemia received nutritional counseling which

involved 1) analysis of 3-day food records, 2) nutritional education regarding fat and cholesterol, and 3) the formulation of a diet plan based on a "substitution" method to meet the NCEP Step-One Diet recommendations. Their research suggested that inclusion of effective dietary adherence-enhancing strategies, such as the substitution of non-atherogenic foods for atherogenic foods, incorporation of out-of-home dining into the dietary recommendations, and modification of food purchasing and preparation practices is critical for successful long-term compliance to a cholesterol lowering diet.

Several studies have highlighted the fact that simple dietary changes may enable children to achieve the NCEP recommendation for total and saturated fat intake. Peterson and Sigman-Grant (1997) found that children who used lean meats in place of higher fat meats achieved the guidelines for total fat intake; however, total energy intake was only 70% of the recommended calories. In this same study it was reported that substituting skim milk for milk with a higher fat content was an economical single-food strategy that could facilitate achievement of contemporary dietary guidelines while maintaining nutrient adequacy (Peterson and Sigman-Grant, 1997). Similar findings were reported in a study by Dixon, et al. (1997). These researchers found that children who reduced their percent of calories from total fat accomplished this by reducing their overall intake of higher-fat food choices and by consuming more servings of lower fat food choices and fruits without compromising their mean calorie or nutrients intakes.

As demonstrated by the review of literature above, there is a paucity of data on strategies nutritional professionals and parent can use to enable children to meet low fat dietary guidelines over time. In particular, no studies have examined dietary changes children with hypercholesterolemia make who successfully lower their saturated fat

intake after an extended period of time. In order to develop successful dietary intervention strategies for children with high cholesterol, nutrition educators need to ask, "Which high fat foods are children likely to reduce in order to comply with the low fat dietary goals?" This question will be the focus of this study.

Research Question:

How do children with hypercholesterolemia change their overall diet when they change their saturated fat intake after 1 year of participating in a clinic-based nutrition intervention focusing on the Step-One Diet?

Hypothesis:

Children with hypercholesterolemia who lower their intake of dietary saturated fat after 1 year of participating in a clinic-based nutrition intervention focusing on the Step-One Diet will have a greater increase in their intake of low-fat foods and a greater decrease in their intake of high-fat foods from all Food Pyramid food groups compared with similar children who do not lower their intake of dietary saturated fat.

Methodology

Subjects

Subjects were recruited from the Children's Hospital Cholesterol Center at the University of Cincinnati Medical Center. Children were referred to the Cholesterol Center by their primary care physician after an initial diagnosis of hypercholesterolemia was made. Families were contacted by phone or letter and invited to participate in the study. Before their scheduled appointment, families met with a registered dietician who gave them the necessary training (as explained below) to complete a 3-day food record. The final sample consisted of those children with scheduled appointments who agreed to

participate in the study, met with a registered dietician, and completed a 3-day food record upon their first visit. All subjects signed informed consents prior to participation. The study was approved by the University of Cincinnati Institutional Review Board.

Children excluded from the study were those with secondary causes of hypercholesterolemia, homozygous LDL-C receptor deficiency (LDL-C > 400mg/dL), or those taking any cholesterol lowering medication. This population was excluded because their dietary management may differ from the typical patient seen at the Center. This project was conducted as part of a larger study funded by the American Heart Association.

Study Design and Methods

The design for this study was a repeated measures design with 3 measurements taken at baseline, 3 months, and at 1 year. For the purpose of this thesis project, only baseline and 1 year results were compared.

All parents of children with a scheduled appointment at the Cholesterol Treatment Center during a selected month were contacted via a letter and a follow-up telephone call and invited to participate in the study. One week prior to their initial visit at the Cholesterol Center, the families who were willing to participate in the study met with a registered dietician who trained them to complete a 3-day food record (in person or by phone). Families were given (or sent) a 2-dimensional portion size model to use at home in order to determine serving sizes and accurately record the quantity of food eaten over the course of three days.

The parents and children were asked to bring the completed food record with them to their initial visit at the Cholesterol Center where a registered dietician reviewed

the record with the child and parents. At that time the dietician checked for details, clarified brand names, etc. In addition, at this initial visit, children were given a routine medical history to complete and a physical examination was performed by the Center cardiologist to detect the manifestations of hypercholesterolemia and causes of secondary hypercholesterolemia. General screenings for risk factors of cardiovascular disease were also conducted (i.e., height, weight, skin fold measurements, blood pressure) by Center staff. Children and their families were asked to give a complete family history regarding heart disease. This included any information on heart disease in family members such as parents, grandparents, aunts, and uncles.

Following this initial assessment, a registered dietician counseled the family on the NCEP Step-One Dietary guidelines for treating pediatric hypercholesterolemia. These recommendations suggest a diet providing less than or equal to 30% of calories from total fat, 10% of calories from saturated fat, less than or equal to 300 milligrams per day of dietary cholesterol, and adequate calories to support growth. A manual was developed by the Cholesterol Center entitled, "Eating for a Healthy Heart", which follows these recommendations. The manual includes an introduction to dietary terminology, lists of low fat and high fat foods categorized by food groups, fat goals, suggestions for identifying low fat foods, modifications of recipes, and other food preparation methods to reduce fat intake. The manual was provided to each family to take home and use between clinic visits.

After their initial visit, families were asked to return to the Cholesterol Center in 3 months and again at 1 year. At each of these visits, a similar protocol as described above was conducted. Prior to the 3-month and 1-year visits, each family received a 3-day food

record with detailed instructions for completion and a 2-dimensional portion size model for reference. Families were called by a dietician and asked if they had any questions about completing the record. Forms were collected and reviewed by a registered dietician at the 3-month and 1-year visits.

Dietary Assessment Measures

3-Day Food Record

Three, 3-day food records were used to record the child's diet; one at the initial visit to the Cholesterol Center prior to receiving formal nutritional counseling (pre-counseling), and one each again at the 3-month and 1-year follow-up visits after receiving formal nutritional counseling. Participants received instruction about completing the food record by a registered dietician prior to formal nutritional counseling. Subjects older than 8 years of age were asked to complete the 3-day food record with the help of their parents. Parents of subjects younger than 8 years of age were asked to complete the 3-day food record with the help of the child. A 2-dimensional portion size model was given to the parents and children to use at home in order to determine the quantity of food eaten. Parents and children were trained to use the model by the registered dietician prior to formal nutritional counseling. At the initial visit, the 3-month visit, and the 1-year visit, completed food records were reviewed by the dietician in a face-to-face session with the families to ensure that accurate documentation of food description, preparation methods, and amounts consumed were recorded.

Nutrient analysis of the food records was performed using the Minnesota Nutrient Data System (NDS, version 2.92). Food lists and quantities of foods (grams) generated from the NDS printout were used to calculate the mean nutrient intakes for the three, 3-

day food records. Nutrient analysis for saturated fat was also used to classify children into two groups for statistical analysis: those that lowered their saturated fat intake after 1 year of intervention versus those that did not.

Food Group Intakes

The methodology used to calculate the number of servings from each food group and the number of servings within subcategories of each food group was modeled after the methodology developed by Dixon (1997). All foods listed on the NDS food record summary files were assigned to one of 8 food categories according to the NCEP guidelines for children (National Cholesterol Education Program, 1991). These 8 food categories were meats, eggs, dairy products, fats/oils, breads, vegetables, fruits, and desserts. Any foods on the food summary file that were listed as components rather than complete foods (e.g., apples, brown sugar, butter) were collapsed into their respective food items (e.g., apple crisp). Gram measurements of foods on the food summary files were converted to the recommended NCEP serving sizes, and the number of servings from subgroups within the major food groups was determined. Subgroups were based on total fat content by NCEP serving size and included low fat foods (less than 3.0 grams), moderate fat foods (3.0 to 5.0 grams), and high fat foods (greater than 5.0 grams). Foods were categorized by fat content based on the grams of fat reported in Bowes and Church's Food Values of Portions Commonly Used (Pennington, 1998).

Data Analysis

Children were divided into two groups for statistical analysis: Group I - those that reduced their intake of saturated fat, and Group II - those that did not reduce their intake of saturated fat after 1 year of participation in a clinic-based dietary intervention program

focusing on the Step One diet. Demographic characteristics, absolute number of servings consumed from the different food groups and fat groups, and the change in number of servings consumed from the different food groups and fat groups were compared between subject groups using student's t-test with a p value<0.05 denoting statistical significance. Mean intakes of dietary components were compared between the two groups.

Results

Forty-three children diagnosed with hypercholesterolemia completed an initial 3-day food record prior to receiving formal nutritional counseling (pre-counseling) and another 3-day food record 1 year after receiving formal nutritional counseling (post-counseling) and were considered participants in this study. Diet records were analyzed for numbers of food servings from 8 food groups based on the NCEP Step-One Diet serving sizes as shown in Table 1. Foods within a food group were sub-grouped into low, medium, and high fat food choices based on the methodology by Dixon et al. (1997) as discussed in the methods section.

Table 2 shows the modification of the food-grouping scheme utilized by Dixon (1997) and for this study. This study examined food choices in the diets of children who had lowered (Group I) versus those who did not change or increased (Group II) their saturated fat intake after 1 year of diet counseling on the Step-One Diet. Table 3 shows the mean change in saturated at intake between groups. Table 4 compares subject characteristics by group. Means (±SD) for age, height, weight, and BMI were similar. Additionally, groups were closely matched for gender and ethnicity.

Mean (±SD) numbers of servings of low, medium, and high fat foods within NCEP Food Groups consumed by children in Group I versus Group II are shown in Table 5. Of note, all food groups contained low, medium, and high fat choices with the exception of fruits (only low fat) and eggs. There were significant differences between groups in intake of mean (±SD) numbers of servings of medium fat dairy foods and high fat vegetables at baseline. Additionally, groups differed in intake of mean (±SD) numbers of servings of high fat meats, eggs, high fat dairy, and high fat vegetable at 1 year.

Figure 1 compares mean change (baseline to 1 year) in low, medium, and high fat servings from NCEP Food Groups for children in Group I versus Group II. Children in Group I (reduced saturated fat intake) reduced their intake of mean total number of servings from high fat dairy foods significantly more than children in Group II (no change or increased saturated fat) ($p < 0.01$). There was a trend ($0.05 < p < 0.1$) for children in Group I to consume fewer servings from high fat meats, eggs, and medium fat dairy food at 1 year.

Table 1. NCEP Serving Sizes

Meat, Poultry, Fish (lean, trimmed, without skin)	Medium pork chop, hamburger patty, cooked meat, ¾ cup diced meat, ½ cup chicken breast, 1 chicken leg and thigh, ¾ cup flaked fish	3 ounces
Eggs	egg	1
Dairy Products (skim, nonfat, or low-fat)	Milk, yogurt Cheese Cottage cheese, frozen dairy dessert	1 cup 1 ounce ½ cup
Fats and Oils	Unsaturated oils, margarine Salad dressing, seeds and nuts (chopped) olives avocado	1 tsp 1 tbsp 5 small 1/8 whole
Breads and Cereals	Bread Hamburger or hot dog bun Corn tortilla Ready to eat cereal Bran -cereal Cooked cereal Pasta, rice, dried beans, potatoes Animal crackers Graham crackers (½" square) Saltine-type crackers Homemade: quick bread (slice), biscuit (2"), corn or bran muffin Pancake (4") Waffle (9") Soup	1 slice ½ 1 1 cup 1/3 cup ½ cup ½ cup 8 3 6 1 1 ¼ 1 cup
Vegetables	Vegetables, raw or cooked	½ cup
Fruits	Fruit Fruit juice	1 medium piece ½ cup
Sweets and Modified Fat Desserts	Fruit-flavored beverages, lemonade, fruit punch Sugar, syrup, honey, jam, preserves Candy corn, hard candy, gum drops Fruit-flavored gelatin Frozen desserts (sherbet, sorbet, fruit ice) Cookies Cake Pie Pudding Ginger snaps Fig bar cookies Angel food cake	6 fluid ounces 1 ½ tbsp ¾ ounce ½ cup 1/3 cup 2 1 slice (1/12 of 2-layer cake or 1/20 of 9"x13") 1 slice (1/8 pie) ½ cup 2 1 1 slice

Table 2. NCEP Guidelines For Representative Foods Within 8 Main Food Groups

Meats Beef, lamb, pork, veal, poultry Game Cold cuts Organ meats Fish Meat substitutes	Fruits Fresh fruits Canned fruits Dried fruits Fruit juices Fruit salads
Eggs Whole eggs Egg whites Egg substitutes	Vegetables Fresh vegetables Canned vegetables Vegetable juices
Dairy Milk, cream Cottage cheese, cream cheese, hard cheese Frozen dairy desserts Baby formula Imitation dairy products	Fats and Oils Animal fats Shortenings Margarines Oils Salad dressings Nuts, seeds, peanut butter Olives, avocados
Breads Yeast breads Baked breads Flour and grains Cereals Pastas and rice Dried beans and peas Legumes and soy products Starchy vegetables Crackers, snacks, and chips Soups	Desserts Cookies Cakes Pies Puddings Doughnuts and pastries Frozen nondairy desserts Sugars, syrups, jellies Frostings, fillings, toppings Dessert sauces Candies

Table 3. *Baseline and 1 Year intake of Percent of Calories From Saturated Fat Consumed by Children: Children Who Reduced Percent Calories From Saturated Fat (Group I) versus Children Who Did Not (Group II).

Time Period	Group I n = 25 % Calories from Saturated Fat (Mean ± SD)	Group II n = 22 % Calories from Saturated Fat (Mean ± SD)
Baseline	11.59 ± 2.20	10.64 ± 1.79
1 year	8.03 ± 2.00	12.70 ± 1.89
Change	-3.55 ± 2.13	2.06 ± 1.62

* Baseline = food data obtained prior to the initial visit at the Cincinnati Children's Hospital Cholesterol Treatment Center

Table 4. Subject Characteristics: Children Who Reduced Percent of Calories from Saturated (Group I) versus Children Who Did Not (Group II).

Demographics	Group I n = 25	Group II n = 22
Age, yrs. (Mean ± SD)	9.52 ± 3.14	9.62 ± 2.66
Height, cm. (Mean ± SD)	1.38 ± 0.20	1.38 ± 0.15
Weight, kg. (Mean ± SD)	45.70 ± 21.40	41.85 ± 12.37
BMI, kg/m^2 (Mean ± SD)	22.53 ± 6.73	21.63 ± 4.97
Gender, n		
Male	12	10
Female	13	12
Ethnicity, n		
White	20	20
Black	4	2
Other	1	

Table 5. Baseline and 1 Year Mean (± SD) Numbers of Calories From Servings From NCEP Food Groups Consumed by Children: Children Who Reduced Percent Saturated Fat (Group I) versus Children Who Did Not (Group II).

Food Groups	**Group I Baseline (Mean ± SD)**	**Group I 1 year (Mean ± SD)**	**Group II Baseline (Mean ± SD)**	**Group II 1 year (Mean ± SD)**
Meats				
Low fat [a]	0.20 ± 0.29	0.20 ± 0.27	0.20 ± 0.25	0.12 ± 0.19
Medium fat [b]	0.19 ± 0.25	0.15 ± 0.31	0.23 ± 0.28	0.23 ± 0.42
High fat [c]	0.84 ± 0.64†	0.53 ± 0.52**†	0.91 ± 0.54†	0.97 ± 0.53**†
Eggs	0.09 ± 0.20†	0.05 ± 0.12**†	0.12 ± 0.24†	0.25 ± 0.31**†
Dairy				
Low fat	0.91 ± 0.98	0.95 ± 0.91	0.65 ± 0.75	0.79 ± 0.51
Medium fat	0.78 ± 0.62*†	0.37 ± 0.53†	0.29 ± 0.44*†	0.29 ± 0.46†
High fat	1.16 ± 1.01	0.37 ± 0.46***	1.11 ± 0.74	1.32 ± 0.75***
Fat/Oil				
Low fat	0.30 ± 0.47	0.60 ± 1.02	0.19 ± 0.43	0.30 ± 0.49
Medium fat	0.55 ± 1.37	0.21 ± 0.65	0.14 ± 0.32	0.08 ± 0.24
High fat	0.79 ± 0.84	0.42 ± 0.52	0.69 ± 0.77	0.73 ± 0.65
Bread				
Low fat	4.57 ± 1.93	4.15 ± 1.66	3.90 ± 1.54	3.80 ± 1.00
Medium fat	0.41 ± 0.76	0.35 ± 0.37	0.45 ± 0.67	0.32 ± 0.44
High fat	0.93 ± 0.94	0.51 ± 0.62	1.06 ± 0.75	0.77 ± 0.71
Vegetable				
Low fat	0.75 ± 0.53	1.03 ± 0.74	0.67 ± 0.48	1.31 ± 0.42
Medium fat	0.01 ± 0.07	0.00 ± 0.00	0.00 ± 0.00	0.02 ± 0.08
High fat	0.01 ± 0.07*	0.00 ± 0.00**	0.11 ± 0.23*	0.07 ± 0.18**
Fruit				
Low fat	1.07 ± 0.93	0.96 ± 0.82	1.52 ± 1.24	0.82 ± 0.47
Dessert				
Low fat	2.89 ± 1.72	2.75 ± 2.11	3.20 ± 1.81	2.98 ± 1.94
Medium fat	0.25 ± 0.41	0.12 ± 0.24	0.20 ± 0.34	0.26 ± 0.49
High fat	0.68 ± 0.73	0.28 ± 0.43	0.53 ± 0.74	0.23 ± 0.47

* significant difference between Group I and Group II children at baseline for mean numbers of servings, $p<0.01$

** significant difference between Group I and Group II children at 1 year for mean numbers of servings, $p<0.01$

***significant difference between Group I and Group II children at 1 year for mean numbers of servings, $p<0.001$

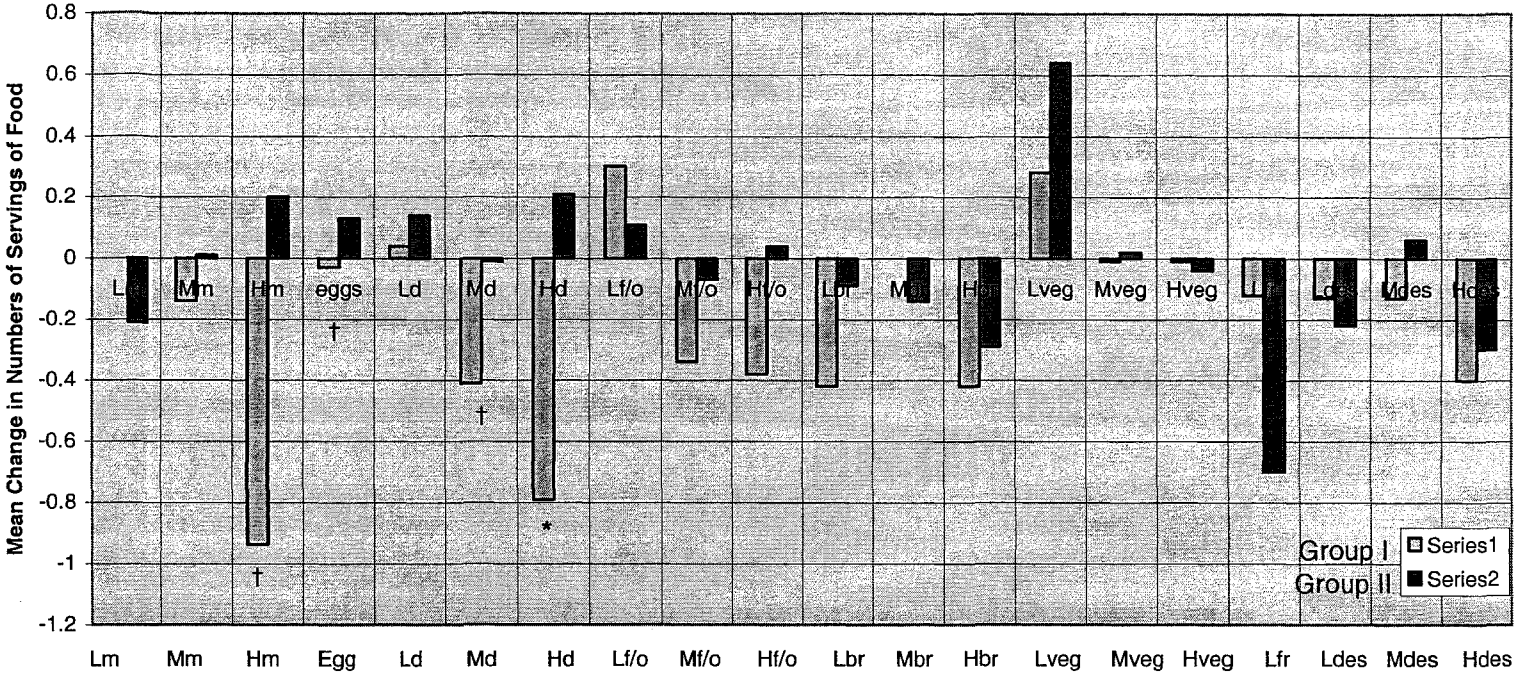
[a] A low fat food from each food group is defined as a food containing < 3 g of fat per serving

[b] A medium fat food from each food group is defined as a food containing 3-5 g of fat per serving.

[c] A high fat food from each food group is defined as a food containing > 5 g of fat per serving.

† trend for significant differences between Group I and Group II: 1 year – baseline mean numbers of serving

Figure 1. **Mean Change After 1 Year in Number of Low, Medium, and High Fat Servings From NCEP Food Groups in the Diets of Children Who Reduced (Group I) versus Did Not Reduce (Group II) Percent of Calories From Saturated Fat**



Series 1 is defined as Group I; Series 2 is defined as Group II

X-axis symbols are as follows:

Lm, Mm, and Hm are defined as low, medium, and high fat meats, respectively.

Ld, Md, and Hd are defined as low, medium, and high fat dairy, respectively.

Lf/o, Mf/o, and Hf/o are defined as low, medium, and high fat fats/oils, respectively.

Lbr, Mbr, and Hbr are defined as low, medium, and high fat breads, respectively.

Lveg, Mveg, and Hveg are defined as low, medium, and high fat vegetables, respectively.

Lfr is defined as low fat fruit.

Ldes, Mdes, and Hdes are defined as low, medium, and high fat desserts, respectively.

* significant difference between Group I and Group II for change in intake of food groups, $p < 0.01$

† trend for difference between Group I and Group II for change in intake of food groups, $0.05 < p < 0.10$

Discussion

The purpose of this study was to assess which foods and respective food groups are the major contributors of fat intake in the diets of children diagnosed with hypercholesterolemia, and, more importantly, which high fat foods children are likely to reduce in order to comply with the NCEP recommendations for treating high blood cholesterol.

In this study, children who lowered their saturated fat intake did so primarily by switching from high fat dairy products, such as premium ice cream and whole milk, to lower fat versions of these products. By continuously offering, for instance, low fat milk to children, repeated exposure of this food occurs and eventual acceptance of this food may increase, as suggested by Birch, et al (1998). In addition to changes in the dairy food group, these children also tended to reduce their consumption of medium fat dairy, high fat meats, eggs, and high fat vegetables while increasing their consumption of low fat choices in these food groups. A similar strategy of repeated exposure to low fat food choices within these food groups could be recommended, potentially leading to permanent incorporation of these foods into the daily diet of children at risk for premature CHD. Nutrition educators could use this information for meal planning in conjunction with nutritional counseling.

We modeled our study after that of Dixon, et al. (1997). The objective of the Dixon study was to determine how healthy children changed their overall diet when they changed their fat intake in order to lower LDL-cholesterol and cardiovascular risk. After 3 months of participating in a nutrition education demonstration study, children who reduced their percent of calories from total fat to meet the NCEP recommendations

accomplished this by reducing their overall intake of higher fat foods, replacing these with lower fat foods within several food groups, particularly dairy. These children also increased their consumption of fruits, vegetables, and very-low fat desserts. Our study was undertaken to further the efforts of Dixon, et al (1997) and determine what specific dietary changes children with hypercholesterolemia make to lower their saturated fat intake, the major contributor to elevated blood cholesterol levels.

While the methodology used in our study was essentially the same as that utilized by Dixon, et al. (1997), there were some differences between the two studies that may explain why our results are slightly different from their findings. The Dixon protocol categorized foods consumed into 10 main food groups (meats, eggs, dairy, fats/oils, breads, vegetables, fruits, desserts, beverages, and gravies/sauces), whereas, this study categorized foods consumed into 8 main food groups (meats, eggs, dairy, fats/oils, breads, vegetables, fruits, and desserts). In both studies, fruit juices were counted in the fruit food group, milk and milk drinks were counted in the dairy food group, and vegetable juices were counted in the vegetable group, however, fruit drinks were categorized differently. In the Dixon study, both fruit juices and fruit drinks were counted in the fruit food group, but in this study fruit drinks were counted in the dessert group. This may explain the greater number of servings of low fat desserts consumed by children in our study. Children in this study consumed more fruit drinks such as Hi-C rather than real fruit juices.

Another difference between studies was the study population. Our subjects were diagnosed with hypercholesterolemia, whereas, in the Dixon study there was a not-at-risk control group. This may account for the overall low consumption of eggs by children in

our study versus a much higher egg consumption by subjects of the Dixon study. Eggs are recognized by the general population as a food group that is high in cholesterol and fat, and one that, based on our study data, can be easily reduced in the diet in order to comply with NCEP recommendations to lower blood cholesterol. For children diagnosed with hypercholesterolemia, this course of action makes sense.

Nutritional education and counseling for a heart-healthy diet can positively impact the diet management of children with hypercholesterolemia. Formal nutritional counseling on the Step-One Diet promotes consumption of low fat food choices from all food groups. This enables individuals to achieve low fat dietary recommendations while enjoying a variety of foods from all food groups. In this study, children who reduced their saturated fat intake 1 year after counseling did so primarily by reducing their intake of high fat dairy foods and also by reducing their intake of medium fat dairy foods, high fat meats, eggs, and high fat vegetables. Dieticians involved in meal planning for this population may first want to emphasize changes within the dairy group (from high fat to low fat choices) as a means of lowering saturated fat in the diet. Additionally, dieticians may suggest selecting low fat rather than high fat versions of the meat and vegetable food groups in combination with low fat dairy. These reasonable dietary alternatives may be an effective means of enabling children with hypercholesterolemia to lower saturated fat in their diet and potentially lower their serum cholesterol levels. Development and implementation of fat and cholesterol lowering strategies aimed at long-term compliance is key to improving diet management and in the prevention of cardiovascular disease for these children.

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