Overrestriction of Dietary Fat Intake Before Formal Nutritional Counseling in Children With Hyperlipidemia

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Objective: To assess the nutritional adequacy of the diets of children with hyperlipidemia following medically unsupervised low-fat diets compared with children receiving unrestricted diets.

Design: Case comparison study.

Patients and Other Participants: Forty-six children were referred to the Children's Cardiovascular Health Center, Columbia–Presbyterian Medical Center, New York, NY, for treatment of hyperlipidemia who had achieved the Step I diet recommendations for total fat before formal nutritional counseling (mean age±SE, 9.7±0.3 years; sex distribution, 24 boys [53%]; ethnicity, 26 Latinos [57%] and 20 whites [43%]; body mass index±SE, 22.4±0.7 kg/m²), and 34 healthy children participating in well-child visits at a local pediatric practice (mean age±SE, 10.2±0.4 years; sex distribution, 18 boys [54%]; ethnicity, 19 Latinos [57%] and 15 whites [43%]; body mass index±SE, 22.5±1.1 kg/m²).

Main Outcome Measures: Three-day food records were analyzed by a registered dietitian using the Minnesota Nutrient Data System. Outcome measures were intakes of calories, total and saturated fats, carbohydrate, protein, essential fatty acids, fat-soluble vitamins, folate, vitamin C, calcium, iron, and zinc.

Results: The percentage of calories from fat and saturated fat was significantly lower in the hyperlipidemic population (mean±SE, hyperlipidemic vs control subjects: total fat, 22.7%±0.7% vs 34.5%±0.6%, P<.001; saturated fat, 7.9%±0.3% vs 12.9%±0.4%, P<.001). The caloric intake in controls was 17% higher than in patients with hyperlipidemia. Ninety percent of the decrease in calories in the hyperlipidemic group could be accounted for by the decrease in total fat intake. After adjusting for calories, no significant difference was noted between the groups for any of the vitamins and minerals mentioned earlier.

Conclusion: Our findings suggest that before formal nutritional counseling, overzealous dietary fat restriction can occur in children with hypercholesterolemia.


Here is strong evidence to suggest that blood cholesterol levels, specifically low-density lipoprotein cholesterol (LDL-C) concentrations, in children play an integral role in the development and progression of coronary heart disease in later life. Dietary modification of fat, saturated fat, and cholesterol intake have been shown to decrease elevated LDL-C concentrations in children, and many professional organizations have made recommendations to decrease dietary sources of these nutrients in both pediatric and adult populations. The Expert Panel on Blood Cholesterol Levels in Children and Adolescents of the National Cholesterol Education Program (NCEP) and the American Heart Association have recommended that children consume a diet containing 30% or less of calories from total fat, less than 10% of calories from saturated fat, and less than 300 mg/d of cholesterol. For those with severe hypercholesterolemia (persistent LDL-C >130 mg/dL [3.36 mmol/L]), a further reduction in saturated fat (<7% of calories) and cholesterol (<200 mg/d) has been advised.

While the NCEP and American Heart Association dietary guidelines have been shown to lower LDL-C levels in children with hyperlipidemia and promote optimal growth and development when medically supervised, case reports have suggested that parent-imposed low-fat diets in the absence of nutritional counseling may have a negative effect on growth and development. This finding is of concern given the recent increase in the num-
SUBJECTS AND METHODS

Children with hyperlipidemia were selected from patients referred between April 1, 1996, and December 31, 1997, to the Children’s Cardiovascular Health Center (CCHC) at Columbia–Presbyterian Medical Center, New York, NY. The CCHC is a referral program for the diagnosis and treatment of hypercholesterolemia and other dyslipidemias present in childhood. Children from the tri-state area (ie, Connecticut, New York, and New Jersey), deemed at risk of atherosclerosis by their pediatrician, are usually referred to the CCHC after the initial diagnosis of hyperlipidemia is made. At the first visit to the CCHC, a detailed medical history, physical examination, fasting lipid profile results, and consent to participate in the program are obtained by the CCHC cardiologist. Additionally, children are given a 3-day food record by a registered dietitian with detailed instructions for its completion. This food record is collected before or at the second visit (approximately 6 weeks from the initial visit). No formal nutritional counseling is provided to families until the second visit to the CCHC.

One hundred three children between 2 and 18 years were referred to the CCHC between April 1, 1996, and December 31, 1997. Of these, 78 children returned a completed 3-day food record before or at the second visit to the CCHC. Forty-six of these children were found (through dietary analysis as described below) to be meeting current NCEP Step I diet recommendations for total fat (≤30% of calories). These children were considered subjects in this study. No child included in these analyses had fasting triglyceride levels higher than 400 mg/dL (3.52 mmol/L) (n = 3 subjects) or homozygous LDL-C receptor deficiency (n = 1 subject). The study population had mean (±SE) total cholesterol, LDL-C, high-density lipoprotein cholesterol (HDLC), and total triglyceride levels that were not statistically significantly different (by t test) from those of all new CCHC patients (study group vs new CCHC patients: total cholesterol, 229.88±8.74 mg/dL [5.94±0.20 mmol/L] vs 217.49±3.75 mg/dL [5.62±0.19 mmol/L]; LDL-C, 166.80±8.51 mg/dL [4.31±0.22 mmol/L] vs 155.96±3.75 mg/dL [4.03±0.20 mmol/L]; HDLC, 40.25±1.55 mg/dL [1.04±0.04 mmol/L] vs 39.47±1.55 mg/dL [1.02±0.04 mmol/L]; and total triglycerides, 113.28±9.74 mg/dL [1.28±0.11 mmol/L] vs 110.63±7.97 mg/dL [1.25±0.09 mmol/L]).

Controls were recruited from local pediatric practices in the vicinity of the Columbia–Presbyterian Medical Center. Children were invited to participate as controls if their parents stated that they were healthy on the day of recruitment, were free of chronic illness, and were not following a modified or restricted diet at the time of the study. All parents signed informed consent forms before their child participated in the study. The study was approved by the Columbia–Presbyterian Medical Center institutional review board.

A registered dietitian or trained research assistant instructed children and parents on how to complete a 3-day food record. Children were asked to complete 3 days of food records, including 2 weekdays and 1 weekend day. Children and parents were trained in estimating portion sizes using common household measuring utensils. Detailed written instructions with pictures of standard serving sizes were provided on the food record form to improve self-reporting of portion sizes and food descriptions. Parents of children 8 years or younger were asked to complete the food record form with the help of the child. Children older than 8 years were asked to complete the record with the help of the parent. No dietary counseling or guidance was given to children or parents at the time of diet-monitoring instruction. Completed diet records were mailed or personally delivered to the CCHC. If clarification was needed on amounts or descriptions of food, children and parents were called or questioned in person by the CCHC registered dietitian.

Anthropometric data on all children were obtained at the time of diet-monitoring instruction. Children’s Cardiovascular Health Center and pediatric clinic patients were measured for height (in centimeters) using a rigid stadiometer, and for weight (in kilograms) using a triple-beam balance scale. Body mass index (BMI) was calculated from these measures as the weight, in kilograms, divided by height, in meters squared.

The Minnesota Nutrition Data System software (Version 2.7), developed by the Nutrition Coordinating Center at the University of Minnesota, Minneapolis, was used to analyze the food record forms. Multivitamin supplements were included in the analyses to assess total micronutrient intake. Nutrients analyzed were calories; total, saturated, polyunsaturated, and monounsaturated fats; linoleic acid; cholesterol; carbohydrate (including total sugars and starch); dietary fiber; protein; fat-soluble vitamins; folate; vitamin C; calcium; iron; and zinc. Macronutrients were expressed as the percentage of total calories. Cholesterol was expressed as milligrams consumed per day. Calories were expressed in absolute amounts and as the percentage of the 1989 recommended dietary allowances (RDAs) based on age and sex. Folate, vitamin C, vitamin D, vitamin E, calcium, vitamin A, zinc, and iron intake were expressed in absolute amounts and as a percentage of the dietary reference intakes (DRIs) based on age and sex.

Statistical analyses were completed using the Statistical Analyses System program (SAS Institute Inc, Cary, NC). t Tests were preformed to determine differences between groups for demographic and nutrient intake data. Analysis of covariance was used to compare group means for nutrient intake after adjusting for caloric intake. The χ² procedure was used to compare the observed vs expected frequency of children within each group for race and sex and for those who were below 75% of the RDA/DRI for caloric and micronutrient intake.

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ries, zinc, calcium, iron, and fat-soluble vitamins. These foods, and consequently these important nutrients, may be unnecessarily restricted in an attempt to implement a low-fat diet. The absence of nutritional counseling in implementing dietary recommendations may influence the nutrient adequacy of the resulting meal plans.

This research evaluated the nutritional quality of low-fat diets imposed by parents of children with hypercholesterolemia before receipt of formal nutritional counseling. We hypothesized that parent-prescribed cholesterol-lowering diets would be less nutritionally adequate than unrestricted diets of children without diagnosed hyperlipidemia.

Subject characteristics are given in Table 1. Groups matched closely for age, racial makeup, sex distribution, and BMI. No significant differences were noted between groups for these demographic variables.

Caloric and macronutrient intakes, with the exception of protein, were different between the groups (Table 2). The children with hyperlipidemia had a lower mean caloric intake. Additionally, the percentage of total calories from fat, saturated fat, polyunsaturated fat, and monounsaturated fat were significantly lower for the group with hyperlipidemia compared with the controls. On average, children with hyperlipidemia consumed well below the NCEP Step I diet, while the controls consumed above these guidelines. Cholesterol intake was lower in the group with hyperlipidemia vs the controls; mean intakes of both groups were below NCEP recommendations. Although the percentage of calories consumed as linoleic acid was lower for the children with hyperlipidemia vs the controls, the mean intake of this essential fatty acid in both groups was within the range recommended by the National Research Council, Food and Nutrition Board.14

In contrast to fat intake, carbohydrates made up a higher percentage of the total calories in the group with hyperlipidemia vs the controls (Table 2). However, a greater proportion of the total calories in the diets of the children with hyperlipidemia vs controls was derived from the total amount of sugars consumed. Notably, a large proportion of the total carbohydrate was derived from total sugars in both groups (children with hyperlipidemia vs controls, mean±SE: 46.8±2.1 vs 47.7±3.0 percentage of total carbohydrate). No differences were noted between the groups for dietary fiber or protein intake.

The mean intakes of the micronutrients are listed in Table 3. The group with hyperlipidemia had lower intakes of zinc and vitamin E compared with controls. Additionally, a trend toward lower iron intake (P=.06) was noted among the children with hyperlipidemia. After micronutrient means were adjusted for total caloric intake, no differences were noted between the groups for any of the vitamins or minerals studied.

Figure 1 shows caloric and micronutrient intake expressed as a percentage of the RDA/DRI. Mean intake of vitamin E and calories were below 75% of the RDA in the group with hyperlipidemia, and were significantly lower than in controls. Mean intake of zinc was lower in the group with hyperlipidemia vs the controls, but above 75% of the RDA for both groups. Although not significantly different, the mean intake of calcium was below 75% of the adequate intake recommendation in both groups.

Figure 2 demonstrates the percentage of children in each group that were below 75% of the RDA/DRI for caloric and micronutrient intake. Of concern, many children in both groups did not meet the RDA for folate, vitamin E, and calories and the adequate intake for calcium. A greater proportion of children with hyperlipidemia

Table 1. Characteristics of the 80 Subjects Studied

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Children With Hyperlipidemia (n = 46)</th>
<th>Control Subjects (n = 34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean ± SE, y</td>
<td>9.7 ± 0.3</td>
<td>10.2 ± 0.4</td>
</tr>
<tr>
<td>Sex, % of M/F</td>
<td>53/47</td>
<td>54/46</td>
</tr>
<tr>
<td>Race, % of Latinos/whites</td>
<td>57/43</td>
<td>57/43</td>
</tr>
<tr>
<td>Body mass index, mean ± SE, kg/m²</td>
<td>22.4 ± 0.7</td>
<td>22.5 ± 1.1</td>
</tr>
</tbody>
</table>

Table 2. Caloric and Macronutrient Intake*

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Children With Hyperlipidemia</th>
<th>Control Subjects</th>
<th>P Value, t Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories, kcal</td>
<td>1502 ± 61.5</td>
<td>1822 ± 80.3</td>
<td>&lt;.001†</td>
</tr>
<tr>
<td>Fat, % kcal</td>
<td>22.7 ± 0.7</td>
<td>34.5 ± 6.6</td>
<td>&lt;.001†</td>
</tr>
<tr>
<td>Saturated</td>
<td>7.9 ± 0.3</td>
<td>12.9 ± 0.4</td>
<td>&lt;.001†</td>
</tr>
<tr>
<td>Polyunsaturated</td>
<td>4.8 ± 0.2</td>
<td>6.4 ± 0.3</td>
<td>&lt;.001†</td>
</tr>
<tr>
<td>Monounsaturated</td>
<td>8.2 ± 0.3</td>
<td>12.5 ± 0.3</td>
<td>&lt;.001†</td>
</tr>
<tr>
<td>Cholesterol, mg</td>
<td>133.8 ± 10.1</td>
<td>239.9 ± 18.3</td>
<td>&lt;.001†</td>
</tr>
<tr>
<td>Protein, % kcal</td>
<td>16.4 ± 0.4</td>
<td>15.6 ± 0.5</td>
<td>.20</td>
</tr>
<tr>
<td>Carbohydrate, % kcal</td>
<td>62.4 ± 0.7</td>
<td>51.1 ± 0.8</td>
<td>&lt;.001†</td>
</tr>
<tr>
<td>Total sugars, % kcal</td>
<td>29.4 ± 1.4</td>
<td>24.6 ± 0.7</td>
<td>.05†</td>
</tr>
<tr>
<td>Starch, % kcal</td>
<td>27.6 ± 0.0</td>
<td>22.5 ± 0.6</td>
<td>&lt;.001†</td>
</tr>
<tr>
<td>Dietary fiber, g</td>
<td>11.3 ± 0.6</td>
<td>11.6 ± 0.6</td>
<td>.80</td>
</tr>
<tr>
<td>Linoleic acid, % kcal</td>
<td>4.4 ± 0.2</td>
<td>5.6 ± 0.3</td>
<td>.01†</td>
</tr>
</tbody>
</table>

*Data are given as mean ± SE.
†Value is statistically significant.
compared with controls did not meet 75% of the RDA for vitamin E and calories.

In this study vitamin and mineral supplements were included in the dietary analysis to obtain information on the total micronutrient intake of the children studied. Dietary supplements reported being consumed were all at or below 100% of the RDAs/DRIs for the vitamins and minerals of interest in this study. To determine whether supplement use mattered for meeting micronutrient recommendations, children taking vitamin and mineral supplements were compared (by $\chi^2$ test) with those not taking supplements for the number of children meeting at least 75% of recommended micronutrient intake levels. A greater frequency of children with hyperlipidemia who were supplement users ($n=9$) vs nonsupplement users ($n=37$) met the RDA for vitamin E ($P<.05$). No differences were noted among the hyperlipidemic supplement users vs nonsupplement users for the number of children meeting at least 75% of the RDA/DRI for folate, vitamin C, vitamin D, vitamin A, zinc, iron, or calcium. Similar findings were observed for the control group.

**COMMENT**

The NCEP’s Step I diet has been advocated for the entire American population older than 2 years to prevent blood cholesterol levels from becoming elevated. Additionally, the diet has been recommended as a cholesterol-lowering therapy for children and adults with high blood cholesterol levels. As part of the Step I diet guidelines for children, the NCEP recommends that adequate calories be provided to support growth and development. The findings from this study suggest that, without formal nutritional counseling, parents of children with hypercholesterolemia may inadvertently overrestrict calories in their children's diet by attempting to eliminate obvious sources of dietary fat. We found that children with hypercholesterolemia before nutritional intervention had significantly lower intakes of vitamin E compared with controls.
lower mean caloric intakes compared with children without hyperlipidemia. Further, 90% of the decrease in caloric intake could be accounted for by a decrease in total fat intake. Both caloric intake and total, saturated, polyunsaturated, and monounsaturated dietary fat intake of the children with hypercholesterolemia were well below established recommendations. Although the length of time between the diagnosis of hypercholesterolemia and formal nutritional counseling was not reported in this study, other clinics have reported that the average duration from the time of diagnosis of hypercholesterolemia in a pediatric population to receipt of formal nutritional counseling ranged from 3 to 20 months. Importantly, several reports citing failure to thrive and malnutrition as consequences of a low-fat diet have been documented among children who delayed receiving formal nutritional intervention after the diagnosis of hypercholesterolemia. It is clear that in these cases parental imposition of a low-fat diet went beyond the present guidelines recommending 30% of calories from fat and adequate calories to support growth. Our data corroborate these case reports suggesting the propensity of some parents to overly restrict calories in an attempt to limit fat in the diets of their children to lower high blood cholesterol concentrations.

Overrestriction of dietary fat can have a negative effect on the overall nutritional quality of children’s diets. We found that children following a parent-prescribed low-fat diet consumed significantly more total sugars than children receiving unrestricted diets. Mean intake of total sugars was 29% of total calories, which is substantially higher than established recommendations for dietary sugar. Data from the Bogalusa Heart Study demonstrated that as the amount of carbohydrates in the diets of children increased, intake of candy, desserts, and nondairy beverages increased as well. It is apparent from the findings in this study and others that some parents attempting to restrict fat in their children’s diets by increasing carbohydrates may inadvertently be promoting increased intake of nonnutrient-dense foods.

In this study, dietary intakes of zinc and vitamin E were significantly lower in the diets of children with hypercholesterolemia vs those receiving unrestricted diets and, for vitamin E, substantially lower than recommended levels. While taking a micronutrient supplement (at levels at or below the RDAs/DRIs) seemed to be beneficial in terms of enabling some children to meet vitamin E recommendations while following a low-fat diet, nutritional authorities suggest food sources as the preferred means of obtaining adequate levels of nutrients for healthy individuals with average requirements. Many of the children with hypercholesterolemia in this study consumed low-fat and low-cholesterol diets by reducing their intakes of foods such as obvious fats and oils, milk, dairy products, meat, and eggs (data not shown). These dietary modifications may explain why dietary vitamin E and zinc levels were affected. Additionally, we found that after adjusting for differences in calories, no differences were noted between the groups for vitamin or mineral intake. This finding suggests that caloric differences between the groups were primarily responsible for differences in vitamin and mineral intake, and further supports the notion that parents of children with hyperlipidemia must be counseled to avoid unnecessary caloric restriction in their children’s diets when encouraging consumption of low-fat diets. Studies in which children have been provided with formal nutritional education to lower intakes of calories from fat and saturated fat showed that the dietary recommendations could be achieved without any untoward effects on intakes of vitamins or minerals.

The results of this study are based on the 3-day dietary record. Despite providing detailed instructions and training to children and parents regarding the recording of food intake in the dietary records, the accuracy of the records can be questioned. The very act of recording food intake may inadvertently result in modified dietary intake, simply by making a subject more aware of what and how much he or she is eating. Although the records of individual participants may occasionally deviate from the true intake, group averages of such records are much more reliable, especially if the average of several days is considered.

While evidence from carefully controlled intervention trials has demonstrated that fat-restricted diets are safe for children, there are clinical reports (as mentioned previously) of children who have grown poorly while following unsupervised low-fat diets. The distinction between these studies and outcomes is in the care with which the diet is administered. Pediatricians who diagnose hypercholesterolemia should be aware that making a suggestion to parents to begin restricting their child’s dietary fat before a visit with a nutritional professional may lead to overzealous restriction of both dietary fat and calories. This may have adverse effects on the nutritional status, growth, and development of the child. Additionally, recent research in nutritional behavior suggests that “stringent” parental control over child-feeding behavior (eg, restricting high-fat foods) can potentiate preferences for high-fat, calorie-dense foods in children. Given the potential for untoward effects of unsupervised very low-fat/low-calorie diets on growth and development and potentially long-term eating behavior, parents of children with newly diagnosed hypercholesterolemia should be strongly encouraged to seek immediate guidance from a registered dietitian after receiving the diagnosis. Registered dietitians are trained to appropriately assist children and their families in translating dietary recommendations into practice.
REFERENCES