Impact of Dietary Fat and Fiber Intake on Nutrient Intake of Adolescents

Theresa A. Nicklas, DrPH, LN*; Leann Myers, PhD‡; Carol O'Neil, PhD, MPH, RD§; and Nancy Gustafson, MS, RD, FADA‖

ABSTRACT. ***Objective.*** **To evaluate the impact of fat and fiber intake on energy and nutrient intake of 15-year-old adolescents.**

Study Design. **Twenty-four-hour dietary recalls were collected on a random sample of 15-year-olds. Subjects were then categorized into groups based on fat and fiber intake, with 319 students meeting criteria for 1 of 4 dietary intake quadrants: low fat, low fiber; low fat, high fiber; high fat, low fiber; and high fat, high fiber. Students with medium fat or fiber intakes were excluded from the study. Low-fat and high-fat intake were defined as <30% and >40% of total energy intake, respectively. Low- and high-fiber intake were defined as <15 g/day and >20 g/day, respectively.**

Results. **Low-fat and high-fiber intake had a minimal impact on energy intake and did not adversely affect nutrient intake. High-fiber intake was associated with greater likelihood of adequate intake of vitamins A, B6, B12, and C; niacin; thiamin; riboflavin; folacin; magnesium; iron; zinc; phosphorus; and calcium. High-fat intake was associated with greater likelihood of adequate vitamin B12 intake. Significant differences in fat and fiber intake distributions were found for ethnic background and gender, with more non-white than white students in the high-fat groups and more males than females in the high-fiber groups.**

Conclusions. **A low-fat and high-fiber diet meeting current nutrition recommendations does not adversely affect energy or nutrient intake, increases nutrient density of the diet, and increases the likelihood of adequate intake for several key nutrients.** ***Pediatrics*** **2000;105(2). URL: http://www.pediatrics.org/cgi/content/full/105/2/e21;** ***adolescence, nutrition, dietary fat, dietary fiber, nutrient adequacy, nutrient intake.***

ABBREVIATIONS. LL, low fat, low fiber; LH, low fat, high fiber; HL, high fat, low fiber; HH, high fat, high fiber; RDA, recommended dietary allowance.

Many scientific organizations recommend moderation in dietary fat intake and an increase in dietary fiber intake for children and adolescents.[1] The National Cholesterol Education Program recommends a diet containing ≤30% of total energy from fat for all Americans 2 years of age or older.[2] The American Academy of Pediatrics recommends a gradual transition between 2 and 5 years of age to a diet containing ≤30% and >20% of energy from fat, with saturated fat providing <10% of energy and dietary cholesterol intake <300 mg/day by 5 years of age.[3] *The Dietary Guidelines for Americans* also recommend a gradual transition to a diet containing ≤30% of energy as fat by 5 years of age.[4] A joint report of the Canadian Paediatric Society and Health Canada advocates a slower transition to a low-fat diet throughout childhood and adolescence, recommending attaining ≤30% of energy from fat by the end of linear growth in late adolescence.[5]

In addition to dietary fat intake recommendations, scientific organizations also make varying recommendations for dietary fiber intake for children and adolescents.[6–9] The American Health Foundation recently proposed a daily fiber intake of "age plus 5," or 5 g of fiber plus 1 g fiber for every year old the child is up to the age of 20, after which the adult intake of 25 to 35 g is recommended.[7,8] In more general terms, goals outlined in *Healthy People 2000* target a minimum fruit and vegetable intake of 5 servings daily.[9]

Although the benefits of low-fat, high-fiber diets for chronic disease prevention in adults are well-documented,[10] some researchers have expressed concern that overzealous use of such diets could compromise the nutritional status of children and adolescents, possibly interfering with normal growth and development.[11,12] Researchers suggest that elimination of high-fat foods could reduce intake of certain nutrients, whereas too much emphasis on high-fiber foods could decrease energy intake or affect bioavailability of nutrients.

A few researchers have reported the effects of adopting a low-fat diet on nutrient intake of younger children[13,14] or a wide age range of children.[15] These studies generally show no adverse effects from lowering fat intake, although 1 study[14] reported potential risk of inadequate intake of certain nutrients with lower fat intake. The effects of a low-fat diet combined with high-fiber intake on nutrient intake of an exclusively adolescent population have not been reported. Adequate nutrient intake is especially important during periods of rapid growth, such as during adolescence. The purpose of this study was to evaluate the impact of low-fat and high-fiber intake on energy and nutrient intake of 15-year-old adolescents. Based on 24-hour recall data, subjects were classified into 4 quadrants of high or low dietary fat

From the *Department of Food and Nutrition, North Dakota State University, Fargo, North Dakota; ‡Tulane School of Public Health and Tropical Medicine, New Orleans, Louisiana; §School of Human Ecology, Louisiana State University, Baton Rouge, Louisiana; and ‖NutriPro Communications, Fargo, North Dakota.

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Reprint requests to (T.A.N.) Department of Food and Nutrition, E Morrow Lebedeff Hall, PO Box 5057, North Dakota State University, Fargo, ND 58105-5057. E-mail: nicklas@badlands.nodak.edu

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and fiber intake, and energy and nutrient intake of subjects in each quadrant were compared.

METHODS

Study Design

This study was part of a larger study, Gimme 5: A Fresh Nutrition Concept for Students. The Gimme 5 program was 1 of 9 studies funded by the National Cancer Institute to evaluate population-based strategies to achieve an intake of 5 fruits and vegetables daily[16] and was designed to increase fruit and vegetable consumption among high school students in Louisiana. More complete details of the Gimme 5 program, including study design, intervention, and process and outcome data, are published elsewhere.[17,18]

In the current study, dietary data from 24-hour recalls collected on a random sample of 711 consenting ninth-grade students during the baseline period (Spring of 1994) of the Gimme 5 program were analyzed. Subjects meeting criteria for 1 of 4 dietary groups based on fat and fiber intake were then identified, including 319 (45%) of the initial 711 participating students. The dietary groups studied were composed of students meeting criteria for 1 of 4 distinct quadrants of dietary fat and fiber intake: low-fat and low-fiber intake (LL group, with intake of fat always listed first and fiber second), low-fat and high-fiber intake (LH group), high-fat and low-fiber intake (HL group), and high-fat and high-fiber intake (HH group).

In this study, low-fat intake was defined as <30% of total energy intake, whereas high-fat intake was defined as >40% of total energy intake. Low-fiber intake was defined as <15 g/day, whereas high-fiber intake was defined as >20 g/day, meeting the age plus 5 recommendation for 15-year-old adolescents. The fat and fiber intake criteria used in this study were designed to include only those students with high- or low-fat and fiber intakes and excluded students with medium intakes to provide 4 distinct and well-defined groups. Intake of energy and nutrients then were compared among groups. Vitamin and mineral intakes were compared on a per 1000 kcal basis to adjust for varying energy intakes.

Subjects

All students were ninth graders attending 1 of 12 different high schools in the Archdiocese of New Orleans, Louisiana. The 711 initial students participating in the 24-hour recall collection included 426 females (60%) and 285 males (40%) with a mean age of 14.8 years. Students were predominantly white (84%), with the remaining students (16%) being African-American, Hispanic, or Asian. The 319 subjects meeting defined criteria for high- or low-fat and fiber intake included 220 females (69% of the 319 subjects) and 99 males (31%). Of these 319 subjects, 82% were white, and 18% were non-white.

Experimental plans, procedures, and consent forms for this study were reviewed and approved by the Tulane University Medical Center Ethics Institutional Review Board for Human Subjects. Active consent was received from the participants.

Dietary Assessment Methodology

Dietary intake data were based on 24-hour recalls collected using a validated method adapted from the Bogalusa Heart Study[19] and the Child and Adolescent Trial for Cardiovascular Health.[20] Trained and certified nutritionists conducted the 24-hour recalls in the schools using a face-to-face interactive interview. All 24-hour recalls were for weekdays and excluded weekend consumption.

Quality controls included a standardized protocol,[21] food models, a product identification notebook for snack probing,[19] and family recipes collected. School menu data also were collected, making it possible to accurately describe dietary intakes from school meals. *The Minnesota Nutrient Data System, Version 2.2* (Nutrition Coordinating Center, University of Minnesota, Minneapolis, Minnesota) was used to analyze the 24-hour recall and school menu data. Additional details of the menu collection and quality assurance procedures are described elsewhere.[22,23]

Intake of vitamins and minerals were compared on a per 1000 kcal basis to adjust for varying energy intakes. Dietary intake data also were compared with the Recommended Dietary Allowances (RDAs).[24] The percentage of subjects meeting or exceeding two thirds of the RDA for a nutrient were compared with the percentage consuming less than two thirds of the RDA as an estimate of nutrient adequacy.

Statistical Analyses

Data were analyzed using analysis of variance techniques with the unweighted means solution for unequal n. Data were analyzed separately by gender and racial distribution to identify differences in gender and ethnic responses. Pairwise comparisons were tested using Newman-Keuls Studentized Range tests. Dietary adequacy data (percentage of subjects meeting two thirds of the RDA) were analyzed using logistic regression methods. Analyses were considered statistically significance at $P < .05$.

RESULTS

Groups Distributions

Of the 711 students initially participating in the 24-hour recall collection, 37.2% had a dietary fat intake <30% of total energy intake, whereas 18.8% had a fat intake >40% of energy intake. Of the students, 21.9% consumed >20 g dietary fiber daily, whereas 56.6% consumed <15 g fiber daily.

Of the 711 students screened, 319 met criteria to be included in 1 of the 4 fat/fiber intake groups. Only 55 students (8% of the original 711 students) met current nutrition recommendations of fat intake <30% of energy and fiber intake >20 g/day, the criteria for the LH group. At the opposite end of the quadrant, 87 students (12% of the original 711 students) had high-fat intake and low-fiber intake (HL group). Another 21% of the original 711 students had low-fat intake but also low-fiber intake (LL group), whereas 4% had high-fat and also high-fiber intake (HH group). The remaining 55% students had medium intakes of fat and/or fiber and were not included in the fat/fiber intake groups.

Table 1 shows the gender and ethnic distributions of the subjects in each of the 4 fat/fiber intake groups included in this study. Significant differences in the distribution of fat/fiber intake groups were found for ethnic background and gender. Fifty percent of non-white students were in the high-fat groups compared with 32% of white students ($P < .05$), but there were no significant differences between the 2 ethnic groups for fiber intake distribution. Although there were no significant differences in gender distribution across the low-fat categories, only 13% of females consumed >20 g fiber/day compared with 54% of males ($P < .0001$).

Energy, Fiber, Cholesterol, and Macronutrient Intakes

Table 2 shows daily intake of energy, fiber, and cholesterol and percentage of energy from macronutrients for each of the fat/fiber groups. Because significant gender differences were found, intakes of females and males are reported separately. Ethnicity was included as an independent variable in the gender-specific analyses.

For females, energy intake of the HH group was significantly higher than all other groups ($P < .0001$), whereas energy intake of the LL group was significantly lower than all other groups ($P < .01$). Energy intake of the HL and LH groups did not differ significantly. For males, subjects in the 2 low-fiber groups consumed less energy than did subjects in the

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TABLE 1. Race and Gender Distribution of the 319 Subjects by Fat/Fiber Intake Categories*

	LL Group *n* (%†‡)	LH Group *n* (%†‡)	HL Group *n* (%†‡)	HH Group *n* (%†‡)	Total *n* (%†‡)
Females					
White	104 (69)	17 (30)	50 (57)	7 (27)	178 (56)
Non-white	19 (13)	1 (2)	19 (22)	3 (11)	42 (13)
All	123 (81)	18 (33)	69 (79)	10 (38)	220 (69)
Males					
White	23 (15)	33 (60)	13 (15)	14 (54)	83 (26)
Non-white	5 (3)	4 (7)	5 (6)	2 (8)	16 (5)
All	28 (19)	37 (67)	18 (21)	16 (62)	99 (31)
Females and males					
White	127 (84)	50 (91)	63 (72)	21 (81)	261 (82)
Non-white	24 (16)	5 (9)	24 (28)	5 (19)	58 (18)
All	151 (100)	55 (100)	87 (100)	26 (100)	319 (100)

* Significant differences in gender ($P < .0001$) and ethnic background ($P < .05$) distributions were found.
† Given as percentage of all subjects in that fat/fiber category.
‡ Percentages do not always add to 100 because of rounding.

TABLE 2. Daily Energy, Fiber, Cholesterol, and Macronutrient Intake of Subjects in Fat and Fiber Intake Groups, by Gender (Mean ± Standard Error of the Mean)

Dietary Variable	LL Group (n = 151)	LH Group (n = 55)	HL Group (n = 87)	HH Group (n = 26)
Energy, kcal				
Females	1438 ± 475	1863 ± 643	1916 ± 590	3397 ± 805
Males	2144 ± 612	3177 ± 1058	2438 ± 625	4450 ± 1211
Fiber, g/d				
Females	9.0 ± 3.2	24.9 ± 3.9	9.3 ± 2.9	25.0 ± 5.5
Males	10.2 ± 2.5	29.8 ± 9.7	10.8 ± 2.9	33.0 ± 11.5
Cholesterol, mg/1000 kcal/d				
Females	65.6 ± 52.3	33.8 ± 20.0	74.7 ± 45.0	21.9 ± 12.5
Males	53.6 ± 33.0	26.4 ± 16.0	49.9 ± 26.3	19.0 ± 9.0
Fat, % kcal				
Females	24.1 ± 5.0	20.6 ± 5.7	44.4 ± 3.5	44.4 ± 3.4
Males	23.2 ± 5.5	24.4 ± 4.5	44.3 ± 4.3	42.8 ± 3.3
Saturated fat, % kcal				
Females	8.6 ± 2.9	6.5 ± 2.1	15.2 ± 4.2	12.9 ± 2.8
Males	8.5 ± 3.0	8.0 ± 2.3	14.7 ± 3.1	14.2 ± 3.5
Protein, % kcal				
Females	14.6 ± 4.8	14.3 ± 4.1	14.4 ± 4.3	11.3 ± 3.2
Males	16.7 ± 5.5	14.9 ± 4.2	14.7 ± 2.4	14.6 ± 2.8
Total carbohydrate, % kcal				
Females	62.7 ± 7.5	68.8 ± 6.5	42.3 ± 5.7	47.2 ± 4.9
Males	60.0 ± 8.7	62.1 ± 4.1	41.6 ± 5.6	44.7 ± 4.5
Sucrose, % kcal				
Females	13.9 ± 7.1	11.8 ± 5.3	8.0 ± 4.9	10.7 ± 4.5
Males	12.8 ± 6.5	9.9 ± 4.7	8.1 ± 4.6	9.7 ± 3.5

high-fiber groups ($P < .001$). Subjects in the LH group had significantly lower energy intakes than subjects in the HH group ($P < .001$).

For both males and females, subjects in the 2 high-fat groups had significantly lower percentages of energy from carbohydrates compared with subjects in the low-fat groups. For females, the 2 high-fat groups also differed from each other ($P < .05$), as did the 2 low-fat groups. For males, no differences in the 2 high-fat or low-fat groups were observed ($P < .01$). For females, subjects in the HL group obtained a significantly lower percentage of their energy from sucrose than did subjects in the LL group ($P < .05$). For males, no significant differences in percentage of energy form sucrose between fat/fiber groups were observed.

As expected, the percentage of energy from saturated fat was higher in both high-fat groups compared with low-fat groups in both males and females ($P < .0001$). For females, the percentage of energy from saturated fat was lower in the HH group than in the HL group ($P < .05$), and lower in the LH group than in the LL group ($P < .05$). For males, no significant differences in the percentage of energy from saturated fat between the 2 high-fat groups or the 2 low-fat groups were observed. Also as expected and by group definition, the percentage of energy from fat was significantly different in both high-fat groups compared with both low-fat groups for both males and females, as was intake of dietary fiber in both high-fiber groups compared with both low-fiber groups. For females, the LL groups had a higher percentage of energy from fat than the LH group ($P < .05$). For males, no significant differences between the 2 high-fat groups or between the 2 low-fat groups were found.

For both males and females, high-fiber groups had significantly lower energy-adjusted cholesterol intakes than low-fiber groups. For females, the HH group had a lower cholesterol intake compared with

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both the low-fiber groups ($P < .01$). Further, the LH group had a lower cholesterol intake compared with both the HL and LL groups ($P < .05$). Patterns were similar for males, with the HH group having a lower cholesterol intake compared with both the LL and HL groups ($P < .0001$), and the LH group having a lower intake compared with the LL group ($P < .001$) and the HL group ($P < .01$).

Vitamin and Mineral Intakes

Table 3 shows intake of 16 vitamins and minerals (adjusted for energy intake) included in the dietary analyses for each of the fat/fiber groups. Again, because of significant gender differences, results for females and males are listed separately.

For both females and males, subjects in the HL group had significantly lower relative intakes of vitamin C compared with subjects in the LH group ($P < .05$). In females, the LH group had significantly higher intakes of folic acid than all 3 other groups ($P < .01$). For males, both high-fat groups had lower intakes of both folic acid and thiamin than the LH group ($P < .05$). For both females and males, the 2 low-fiber groups had lower intakes of magnesium than the 2 high-fiber groups ($P < .05$), with greater differences between the HL and the LH groups ($P < .0001$ for females and $P < .01$ for males).

For females, the LH group had significantly higher intakes of potassium than all the other 3 groups ($P < .01$). For non-white males, the LH group had significantly higher potassium intakes than all other groups ($P < .001$). No significant differences in potassium intakes among groups were noted for white males. For all males, several significant differences in sodium intake were found among groups, with no particular pattern noted.

TABLE 3. Daily Vitamin and Mineral Intake of Subjects in Fat and Fiber Intake Groups Expressed per 1000 kcal, by Gender (Mean ± Standard Error of the Mean)

Dietary Variable	LL Group ($n = 151$)	LH Group ($n = 55$)	HL Group ($n = 87$)	HH Group ($n = 26$)
Vitamin A, μg				
Females	549 ± 506	1561 ± 1572	325 ± 228	457 ± 384
Males	530 ± 519	508 ± 400	394 ± 334	334 ± 268
Vitamin D, μg				
Females	4.0 ± 4.1	4.0 ± 3.9	2.6 ± 1.9	2.8 ± 2.6
Males	3.5 ± 3.3	3.4 ± 2.2	3.1 ± 1.6	2.5 ± 1.9
Vitamin B6, mg				
Females	1.2 ± .9	1.6 ± 1.1	.8 ± .4	1.0 ± .6
Males	1.1 ± .7	1.2 ± .8	.8 ± .4	.8 ± .3
Vitamin B12, μg				
Females	2.6 ± 2.7	3.1 ± 2.9	1.9 ± 1.3	1.9 ± 1.3
Males	2.7 ± 3.4	2.8 ± 2.0	2.4 ± 1.1	2.1 ± 1.3
Thiamin, mg				
Females	1.2 ± 1.3	1.5 ± .8	.8 ± .6	1.2 ± .6
Males	1.1 ± .6	1.2 ± .4	.8 ± .3	.9 ± .4
Riboflavin, mg				
Females	1.3 ± 1.4	1.4 ± .8	1.0 ± .7	.8 ± .4
Males	1.2 ± .7	1.2 ± .5	1.0 ± .3	.9 ± .4
Niacin, mg NE				
Females	13.5 ± 13.5	16.2 ± 10.5	9.6 ± 6.7	9.6 ± 5.7
Males	14.9 ± 8.9	13.2 ± 6.3	9.0 ± 3.3	10.6 ± 4.7
Vitamin C, mg				
Females	110.2 ± 134.6	160.8 ± 188.2	50.8 ± 62.7	76.8 ± 100.8
Males	72.0 ± 58.9	104.4 ± 85.5	28.3 ± 20.2	75.6 ± 134.9
Folate, μg				
Females	201.1 ± 151.9	325.1 ± 245.2	116.2 ± 73.3	173.0 ± 115.9
Males	180.3 ± 141.2	243.4 ± 133.5	109.1 ± 64.8	142.8 ± 87.7
Calcium, mg				
Females	460.0 ± 266.2	456.9 ± 171.2	449.8 ± 261.0	309.2 ± 65.5
Males	434.0 ± 349.3	471.5 ± 204.9	488.7 ± 192.1	421.4 ± 172.4
Phosphorus, mg				
Females	620.8 ± 219.4	664.5 ± 197.8	627.6 ± 225.6	567.6 ± 169.6
Males	617.2 ± 235.5	652.7 ± 178.7	630.0 ± 155.4	659.5 ± 142.1
Magnesium, mg				
Females	135.1 ± 49.3	191.6 ± 78.3	115.3 ± 36.2	170.3 ± 91.5
Males	117.5 ± 31.9	151.8 ± 49.2	107.9 ± 34.7	151.4 ± 40.2
Iron, mg				
Females	35.8 ± 301.1	13.0 ± 8.3	5.8 ± 2.9	7.5 ± 3.7
Males	9.0 ± 6.5	10.8 ± 5.5	6.0 ± 2.8	7.1 ± 5.6
Zinc, mg				
Females	6.1 ± 4.1	7.5 ± 5.1	5.0 ± 2.5	6.1 ± 3.6
Males	5.7 ± 3.5	6.8 ± 4.7	5.4 ± 2.0	5.7 ± 1.8
Potassium, mg				
Females	1310.1 ± 476.2	1680.6 ± 425.0	1113.7 ± 319.1	1146.8 ± 297.3
Males	1118.7 ± 295.7	1447.8 ± 436.0	1071.2 ± 269.1	1175.7 ± 234.5
Sodium, mg				
Females	1307.7 ± 997.8	1110.3 ± 651.3	1058.7 ± 700.1	390.5 ± 149.3
Males	888.8 ± 637.3	541.2 ± 229.0	640.1 ± 317.8	318.3 ± 138.2

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Dietary Adequacy

Figures 1 and 2 give the percentage of subjects in each group consuming less than two thirds of the RDA for each of the vitamins and minerals included in the analysis. Analysis of RDA adequacy using logistic regression methods showed that, regardless of fat intake, subjects with high dietary fiber intake were more likely to have adequate intakes of vitamins A, B6, B12, and C; niacin; thiamin; riboflavin; folacin; magnesium; iron; zinc; phosphorus; and calcium compared with subjects with low dietary fiber intake. Regardless of fiber intake, subjects with high dietary fat intake were more likely to have adequate intakes of vitamin B12 compared with subjects with low-fat intake.

DISCUSSION

The results of this study of 15-year-old students indicate that adolescents with a low-fat intake and a high-fiber intake consumed more nutrient dense diets compared with adolescents in other fat/fiber intake groups. Low-fat and high-fiber intake did not adversely affect nutrient intake, and high-fiber intake was associated with greater likelihood of adequate intake of several key nutrients, including vitamins A, B6, B12, and C; niacin; thiamin; riboflavin; folacin; magnesium; iron; zinc; phosphorus; and calcium. High-fat intake was associated with greater likelihood of adequate vitamin B12 intake.

Low-fat and high-fiber intake had a minimal impact on energy intake in this population. Although energy intake of the LL group was less than energy intakes of both high-fat groups for females, energy intake of the LH group did not differ significantly from the HL group. For males, low-fat intake did not significantly affect energy intake. Rather, high-fiber intake was associated with higher energy intakes.

Many investigators have expressed concern that limiting fat intake in childhood could adversely affect energy and nutrient intake, limiting normal growth and development. Some researchers have reported poor growth in children on low-fat diets,[25] although the risk may lie in low-energy diets rather than low-fat diets themselves. Other investigators warn against inadequate intakes of nutrients with low-fat diets, particularly for iron and calcium.[26]

In a study of 10-year-old children, Nicklas and colleagues[27] noted a higher percentage of children not meeting the RDA for several nutrients in children consuming <30% of energy as fat, compared with children consuming >30% fat. However, authors also note that the diets of these children were self-selected and that high-fat foods seem to have been replaced with high-sucrose foods rather than with lean meats, whole grains, fruits, and vegetables. Because data in this study were based on one 24-hour recall, failure to meet two thirds of the RDA for a nutrient only indicates potential risk for inadequate intake, not an actual nutrient deficiency.

In a randomized trial investigating the long-term safety of fat reduction in 663 children 8 to 10 years of age,[14] lower fat intake was related to higher intakes of folate, vitamin C, and vitamin A, with a trend toward higher intakes of iron. However, lower fat intake also was related to lower intakes of calcium, zinc, magnesium, phosphorus, vitamin B12, thiamin, niacin, and riboflavin and to an increased risk of consuming less than two thirds of the RDA for calcium in girls and zinc and vitamin E in boys and girls. Although intake of some nutrients was lower in the low-fat group, no adverse effects on blood biochemical measures were observed, and authors conclude moderately low-fat intakes are safe for children.

Although the combined effects of low-fat and high-fiber intake have not been previously reported in an adolescent population, other studies report a positive effect of fat reduction on nutritional adequacy in the diets of children.[13,28–30] In a study of 304 children 4 to 10 years of age, lowering the percentage of energy from fat did not affect energy or nutrient intake.[13] In a study of 174 schoolchildren 8 to 12 years of age, children consuming <30% energy as fat had similar energy intakes but increased energy-adjusted intakes of thiamin, niacin, folate, vitamin C, magnesium, and iron compared with children consuming

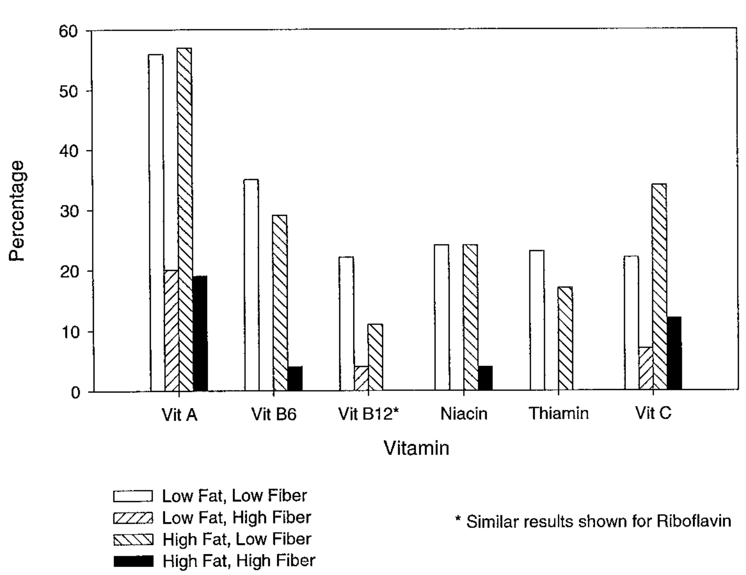

Fig 1. Percentage of subjects in each group consuming less than two thirds of the RDAs for selected vitamins.

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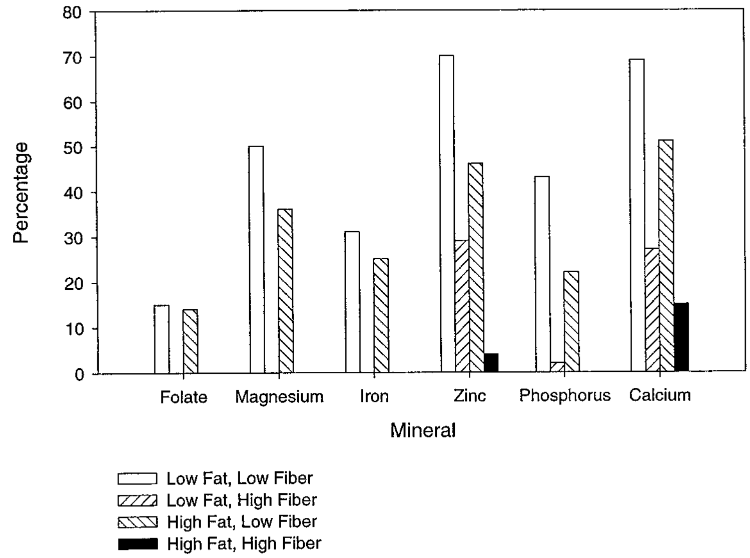

Fig 2. Percentage of subjects in each group consuming less than two thirds of the RDAs for selected minerals.

>30% fat.[30] In the Child and Adolescent Trial for Cardiovascular Health, a school-based intervention program designed to reduce cardiovascular risk resulted in significant decreases in the percentage of energy from fat and saturated fat in the intervention compared with a control group. In this study, decreased fat intake was associated with increased vitamin and nutrient density in the diet.[29]

Using a sorting procedure on data from the 1989–1991 Continuing Survey of Food Intake by Individuals, Peterson and Sigman-Grant[15] compared nutrient intake of children 2 to 19 years of age who used exclusively skim milk, lean meats, or fat-modified products. Compared with all children sampled, children who exclusively used skim milk had lower fat intakes while maintaining energy and micronutrient intakes, as did those who used fat-modified products such as fat-modified cheeses, salad dressings, cakes, puddings, and yogurts. Children who used exclusively lean meats had lower energy and vitamin E intakes compared with the general sample.

With the exception of greater likelihood of inadequate vitamin B12 intakes with low-fat intake, no adverse nutritional effects from low-fat and high-fiber intake were found in this study. Rather, low-fat and high-fiber intake was associated with greater nutritional adequacy for several nutrients. The higher nutrient density and intake of many vitamins and minerals in students with a low-fat and high-fiber intake in this study may reflect inclusion of a greater variety of food choices, particularly of fruits and vegetables.

Interpretation of this study is limited because it was conducted with predominantly white students residing in middle to upper class households. More research is needed to determine how low-fat and high-fiber intake affects individuals with other ethnic and socioeconomic backgrounds. Although self-reported dietary data also have inherent limitations, including risk of underreporting intake, a standardized protocol was carefully followed in this study to increase accuracy of the data.

The criteria for low-fat intake and high-fiber intake in this study were chosen to meet current nutrition recommendations of a fat intake of <30% of energy and a fiber intake of age plus 5. Although controversy continues regarding the most appropriate dietary fat and fiber intake recommendations for children and adolescents, the diets of most American children fall short of meeting both fat and fiber levels regardless of the recommendations chosen. Although levels of fat intake have been steadily decreasing in the diets of US children over the past several years, 70% of US children still exceed current dietary recommendations for total fat and saturated fat intake.[1]

Results of the 1994–1996 Continuing Survey of Food Intakes by Individuals of the US Department of Agriculture show an average daily fat intake of 33% and 34% of energy for females and males 12 to 19 years of age, respectively.[31] The same survey results with the same age group show an average fiber intake of 13.0 g and 17.4 g for females and males, respectively. In the current study, only 4% of females and 13% of males initially screened met criteria for both low-fat and high-fiber intake.

Adolescence is characterized by rapid growth and high nutritional requirements. In addition to physiologic requirements, growing independence, demands of school and work, peer pressure, and changing food choices all combine to make this group nutritionally vulnerable.[32] Based on results of this study, a low-fat and high-fiber intake meeting current nutrition recommendations does not adversely affect energy or nutrient intake, raises nutrient density, and increases the likelihood of adequate nutrient intake for several key nutrients. Health professionals should counsel adolescents to decrease fat intake and increase fiber intake in conjunction with exercise and other lifestyle habits to promote the health and well being of this population.

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REFERENCES

1. Position of the American Dietetic Association: dietary guidance for healthy children aged 2 to 11 years. *J Am Diet Assoc*. 1999;99:93–101
2. US Department of Health and Human Services. *National Cholesterol Education Program: Report of the Expert Panel on Blood Cholesterol Levels in Children and Adolescents*. Washington, DC: US Department of Health and Human Services; 1991. NIH Publication 91-2732
3. American Academy of Pediatrics, Committee on Nutrition. Cholesterol in children. *Pediatrics*. 1998;101:141–147
4. US Departments of Agriculture and Health and Human Services. *Nutrition and Your Health: Dietary Guidelines for Americans*. 4th ed. Washington, DC: US Departments of Agriculture and Health and Human Services; 1995. Home and Garden Bulletin 232
5. Joint Working Group of the Canadian Paediatric Society and Health Canada. *Nutrition Recommendations Update: Dietary Fat and Children*. Ottawa, Ontario: Health Canada; 1993
6. American Academy of Pediatrics, Committee on Nutrition. *Pediatric Nutrition Handbook, 4th ed*. Elk Grove Village, IL: American Academy of Pediatrics; 1998
7. Williams CL, Bollella M, Wynder EL. A new recommendation for dietary fiber in childhood. *Pediatrics*. 1995;96:985–988
8. Williams, CL. Importance of dietary fiber in childhood. *J Am Diet Assoc.* 1995;95:1140–1146
9. US Department of Health and Human Services. *Healthy People 2000: National Health Promotion and Disease Prevention Objectives*. Washington DC: Public Health Service, US Department of Health and Human Services; 1991
10. Trichopoulou A, Lagiou P. Worldwide patterns of dietary lipids intake and health implications. *Am J Clin Nutr*. 1997;66:S961–S967. Supplement 4
11. Newman TB, Garber AM, Holtzman NA, et al. Problems with the report of the expert panel on blood cholesterol levels in children and adolescents. *Arch Pediatr Adolesc Med*. 1995;149:241–247
12. Lifshitz F, Tarim O. Considerations about dietary fat restrictions for children. *J Nutr*. 1996;126:1031–1041. Supplement
13. Dixon LB, McKenzie J, Shannon BM, Mitchell DC, Smiciklas-Wright H, Tershakovec AM. The effect of changes in dietary fat on the food group and nutrient intake of 4- to 10-year-old children. *Pediatrics*. 1997;100: 863–872
14. Obarzenik E, Hunsberger SA, Van Horn L, et al. Safety of a fat-reduced diet: the Dietary Intervention Study in Children (DISC). *Pediatrics*. 1997; 100:51–59
15. Peterson S, Sigman-Grant M. Impact of adopting lower-fat food choices on nutrient intake of American children. *Pediatrics*. 1997;100(3). URL: http://www.pediatrics.org/cgi/content/full/100/3/e4
16. Havas S, Heimendinger J, Damron D, et al. 5-A-Day for Better Health: nine community research projects to increase fruit and vegetable consumption. *Public Health Rep*. 1995;110:68–79
17. Nicklas TA, Johnson CC, Myers L, Farris RP, Cunningham A. Outcomes of a high school program to increase fruit and vegetable consumption: Gimme 5—A Fresh Nutrition Concept for Students. *J Sch Health*. 1998; 68:248–253
18. Nicklas TA, Johnson CC, Farris R, Rice R, Lyon L, Shi R. Development of a school-based nutrition intervention for high school students: Gimme 5. *J Sch Health*. 1997;11:315–322
19. Farris RP, Nicklas TA. Characterizing children's eating behavior. In: Suskind RM, Suskind LL, eds. *Textbook of Pediatric Nutrition*. 2nd ed. New York, NY: Raven Press Ltd; 1993:505–516
20. Lytle LA, Nichaman MZ, Obarzanek E, et al. Validation of 24-hour recalls assisted by food records in third-grade children. *J Am Diet Assoc*. 1993;93:1431–1436
21. Bogalusa Heart Study Nutrition Staff. *In-House Dietary Studies Methodology*. 1st–8th ed. New Orleans, LA: Tulane School of Public Health and Tropical Medicine; 1984–1996
22. Nicklas TA, Forcier JE, Webber LS, Berenson GS. School lunch assessment to improve accuracy of 24-hour dietary recalls for children. *J Am Diet Assoc*. 1991;91:711–713
23. Ebzery, MK, Montgomery DH, Evans MA, et al. School meal data collection and documentation methods in a multisite study. *Sch Food Service Res Rev*. 1996;20:69–77
24. Food and Nutrition Board. *Recommended Dietary Allowances*. 10th ed. Washington DC: National Academy of Sciences; 1989
25. Lifschitz F, Moses N. Growth failure: a complication of dietary treatment of hypercholesterolemia. *Am J Dis Child*. 1989;143:537–542
26. Mauer AM. Should there be intervention to alter serum lipids in children? *Ann Rev Nutr*. 1991;11:375–391
27. Nicklas TA, Webber LS, Koschak ML, Berenson GS. Nutrient adequacy of low fat intakes for children: the Bogalusa Heart Study. *Pediatrics*. 1992;89:221–228
28. Pietinen P, Dougherty R, Mutanen M, et al. Dietary intervention study among 30 free-living families in Finland. *J Am Diet Assoc*. 1994;84: 313–318
29. Nicklas TA, Dwyer J, Mitchell P, et al. Impact of fat reduction on micronutrient density of children's diets: the CATCH Study. *Prev Med*. 1996;25:478–485
30. Tonstad S, Sivertson M. Relation between dietary fat and energy and micronutrient intake. *Arch Dis Child*. 1997;76:416–420
31. US Department of Agriculture, Agricultural Research Service. Data tables: results from USDA's 1994–1996 continuing survey of food intakes by individuals and 1994–1996 Diet and Health Knowledge Survey. *1994–1996 Continuing Survey of Food Intakes by Individuals and 1994–1996 Diet and Health Knowledge Survey* [book on CD-ROM]; 1997. NTIS Accession Number PB98-500457
32. Neumark-Sztainer D, Story M, Resnick MD, Blum RW. Lessons learned about adolescent nutrition from the Minnesota Adolescent Health Survey. *J Am Diet Assoc*. 1998;98:1449–1456

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