The Dietary Intake of Children With IDDM

GREG A. RANDECKER, BS
HELEN SMICIKLAS-WRIGHT, PHD
JEANNIE M. MCKENZIE, DRPH, RD
BARBARA M. SHANNON, PHD, RD
DIANE C. MITCHELL, MS, RD
DOROTHY J. BECKER, MB, BCH
KESSEY KIESELHORST, MPA, RD, CDE

OBJECTIVE — To assess the dietary intake of children with IDDM and to determine whether the intake meets the current nutritional recommendations for children with IDDM.

RESEARCH DESIGN AND METHODS — A total of 66 children with IDDM who were <10 years of age were recruited from two suburban Pennsylvania hospitals. To collect dietary intake data, subjects were asked, via telephone interview, to complete three random-day 24-h dietary recalls. Data were analyzed for the content of nutrients and other food components by a computerized database program. Intakes were expressed as a 3-day average intake for each subject.

RESULTS — Overall mean intake of protein and cholesterol approximated the current recommendations. The mean intake of saturated fat exceeded recommendations, while fiber intake was less than the recommended level. Many of the children consumed levels of saturated fat well above recommendations. Energy, vitamin, and mineral intakes were adequate for the overall sample. However, from 10 to 40% of the sample had an inadequate intake of vitamin D, vitamin E, and zinc. The percentage of those with inadequate intakes of these nutrients decreased with age.

CONCLUSIONS — These data suggest that, on average, among this sample of children with IDDM aged <10 years, adherence to the current nutritional recommendations for children with IDDM was adequate, but some individual children had intakes that were not consistent with the recommendations for optimal management of IDDM.

The goals for the management of IDDM in children are to give a safe blood glucose target range to ensure against severe hypoglycemia, to sustain adequate growth and development, to prevent and treat acute and chronic complications that are associated with the disease, and to improve overall health through optimal nutrition (1). The achievement of these goals relies, in part, on dietary management, which includes the development of an individualized meal plan based on usual eating habits, lifestyle factors, and the outcome goals of the child (2). Compliance to the dietary prescription is viewed as important for optimal management of IDDM. Despite this, dietary compliance among individuals with IDDM has been reported to be poor (3–6).

Current macronutrient recommendations encourage protein from both animal and vegetable sources that comprise 10–20% of energy, liberal carbohydrate intake based on the patient's eating habits and glucose and lipid goals, and fat limited to <10% of energy from saturated fat (1). These are guidelines that must be individualized, depending on blood glucose and lipid levels. Protein recommendations would be lower for individuals with evidence of nephropathy.

Sucrose was once believed to cause a greater glycemic response than other carbohydrates (7) and thus totally proscribed. However, recent research shows that sucrose may be incorporated into the meal plan, provided that sucrose and sucrose-containing foods are substituted for other carbohydrates and foods, not simply added to the meal plan (1). The ingestion of dietary fiber, especially soluble fiber, has been shown to decrease the postprandial glycemic response in children with IDDM (8,9). The fiber intake of children in the United States tends to be low (10). Increasing the fiber content of the diet in all children should be encouraged. Although a diet high in fiber may be important, it has also been suggested that a high-fiber diet in some children may result in insufficient caloric intake and the impairment of mineral absorption (10). A balance of these factors on an individual basis should be achieved.

The American Diabetes Association (ADA) (1) recommends that saturated and polyunsaturated fats each comprise <10% of energy and monounsaturated fats up to 20% of energy. IDDM has been shown to be associated with an increased risk of cardiovascular disease (11–13). Slightly disturbed cardiovascular risk profiles have been reported in adolescents with IDDM, compared with their siblings without diabetes (14). For these reasons, it is recommended that cholesterol intake should not exceed 300 mg per day, in accord with recommendations of the National Cholesterol Education Program (NCEP) (15) for the management of hypercholesterolemia in all children and adolescents >2 years of age.

Protein intake for the child with IDDM must be sufficient to ensure adequate growth (1). Presently, there are no data to support protein intake at levels higher or lower than the Recommended Dietary Allowances (RDA) (1,16). This translates to 1.0–1.2 grams of protein per kilogram of body weight or 10–20% of energy intake.

While much of the focus of the relationship between diet and diabetes has been on macronutrient content, proper micronutrient intake should also be achieved for optimal health. Vitamin and mineral intake should meet the established requirements for health (1). Provided that the diet is adequate, children with IDDM do not require or seem to benefit from dietary supplementation of vitamins or minerals (1,17).

From the College of Health and Human Development (G.A.R., H.S.-W., J.M.M., B.M.S., D.C.M.), Nutrition Department, Pennsylvania State University, University Park; the Department of Pediatrics (D.J.B.), Children's Hospital of Pittsburgh, University of Pittsburgh School of Medicine, Pittsburgh; and the College of Medicine (K.K.), Department of Clinical Nutrition, Milton S. Hershey Medical Center, Hershey, Pennsylvania.

Address correspondence and reprint requests to Helen Smiciklas-Wright, PhD, S125 Henderson Building, University Park, PA 16802. E-mail: hsw@psu.edu.

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ADA, American Diabetes Association; NCEP, National Cholesterol Education Program; RDA, Recommended Dietary Allowances.

Table 1—*Macronutrient, saturated fat, cholesterol, and fiber intake*

Nutrient	Recommended intake	Actual intake
Protein (% kcal)	10–20	16.9 ± 3.1
Carbohydrate (% kcal)	—	52.7 ± 8.1
Fat (% kcal)	—	31.6 ± 7.2
Saturated fat (% kcal)	<10	11.4 ± 3.1
Cholesterol (mg/day)	<300	206.6 ± 138.9
Fiber (g/day)	20–35	16.6 ± 6.5

Actual intake data are means ± SD. Recommended intake for protein, saturated fat, cholesterol, and fiber are from the ADA recommendations; carbohydrate and fat recommendations are not presented as a percentage of the total kcal in the ADA recommendations.

Despite the recognition that dietary management is an important component of overall care for children with IDDM, published scientific literature provides little about these children's actual dietary intakes. Some investigators have reported deviations of intake from the recommended meal plan (i.e., exchange lists), where children add or delete approximately one out of four prescribed exchanges (3,18). Only one study (19) has reported the nutrient intake of children with IDDM and compared them with the recommendations. The authors reported overconsumption of total and saturated fat and protein by children with IDDM (3–9 years of age). However, these data were based on a small sample (n = 10) and only one 24-h dietary recall, factors which limit the ability to assess the distribution of nutrient intakes and the average intake of the sample.

The purpose of this study was to determine the usual dietary intake of children with IDDM and to assess whether the nutritional recommendations and dietary guidelines for macro- and micronutrients are being met. The study was approved by the Pennsylvania State University's Office for Regulatory Compliance, Children's Hospital of Pittsburgh Internal Review Board, and The Milton S. Hershey Medical Center Internal Review Board.

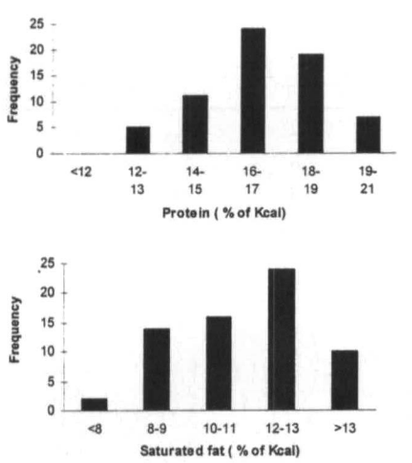

Figure 1—*Distribution of protein and saturated fat.*

RESEARCH DESIGN AND METHODS

— Subjects were children <10 years of age who were recruited from two Pennsylvania hospitals, Children's Hospital of Pittsburgh and The Milton S. Hershey Medical Center. Subjects who met the inclusion criteria of a positive diagnosis of IDDM and <10 years of age were included in this study. Age, sex, and duration of diabetes were recorded for each subject at a scheduled clinic visit. Age was expressed in years and defined as length of time from date of birth to the clinic visit. The duration of diabetes was expressed in years and defined as the length of time from the physician's diagnosis of diabetes to the clinic visit. Before participation in this study, subjects had been receiving each hospital's standard medical and nutrition education program for diabetes care and diet. There were differences between the two hospitals' approach to nutrition education for the children. One facility utilized an ADA exchange system, while the other used a "no concentrated sweets" method.

Sixty-six children (34 female and 32 male) with a mean age of 7.1 ± 1.7 years participated in the study. Twenty-seven children were 4–6 years of age (12 female and 15 male), and 39 children were 7–9 years of age (22 female and 17 male). The mean duration of diabetes was 2.9 ± 1.9 years with a range of 0.2–6.6 years.

Dietary intake data were collected by the Pennsylvania State University Diet Assessment Services. Three random 24-h dietary recalls were collected within a 2-week period via telephone interviews by trained interviewers. The interviews were conducted only if the child and one of the child's primary caregivers were present to assist in determining food portion sizes and foods eaten away from home. The random days used to assess dietary intake were computer generated and included 2 weekdays and 1 weekend day (Saturday or Sunday). This method of collection was used to help determine typical intakes. Dietary intakes were assessed using the Minnesota Nutrition Data System (food database version 4A and nutrient database version 21, Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN). The nutrient intake data described in this paper represent nutrients derived solely from food. However, during the six 24-h dietary recalls, 28 of the 66 children enrolled in this study reported to have taken a multivitamin and mineral supplement at least once. Energy, nutrient content, and other food components were determined and expressed as 3-day averages for each child. The intake of macronutrients, saturated fat, cholesterol, and fiber were compared with recommended intakes (1,21). Vitamin and mineral intakes were compared with the RDA (16). Vitamin and mineral intakes were also expressed as percentages of the RDA (<77, 77–100, and ≥100%) to assess the adequacy of intakes. The cutoff of <77% was based on the assumption that the RDA is set two standard deviations above mean requirements. Therefore, an intake of 77% of the RDA would theoretically represent the mean nutrient requirement (22).

Descriptive statistics (mean, SD, and ranges) were generated to describe the sample and overall dietary intake levels.

RESULTS

— Intake of macronutrients, saturated fat, cholesterol, and fiber by all children is shown in Table 1. The mean intake of protein and cholesterol was within recommended levels. Mean intake of saturated fat was at levels slightly higher than those recommended.

The distribution of percentage of calories from protein and saturated fat is shown in Fig. 1. Protein intake was within recommended levels for all but one of the children in the sample; many of the children consumed levels at the upper limit of what was recommended. Although the

Table 2—*Energy, vitamin, and mineral intake*

Nutrient	4–6 years of age (n = 27) 1989 RDA	4–6 years of age (n = 27) Intake	7–9 years of age (n = 39) 1989 RDA	7–9 years of age (n = 39) Intake
Energy (kcal)	1,800	1,772 ± 427	2,000	2096 ± 483
Calcium (mg)	800	1,088.2 ± 386.3	800	1338.9 ± 378.7
Iron (mg)	10	13.6 ± 6.2	10	15.5 ± 7.1
Phosphorous (mg)	800	1,338.6 ± 415.0	800	1611.0 ± 372.0
Zinc (mg)	10	9.9 ± 4.6	10	11.8 ± 3.7
Vitamin A (μg RE)	500	1,089.1 ± 1012.1	700	1283.8 ± 739.7
Vitamin E (μg ∝-toc eq)	7	7.9 ± 5.1	7	7.8 ± 3.4
Vitamin D (μg)	10	8.0 ± 3.2	10	9.5 ± 3.2
Vitamin C (mg)	45	83.1 ± 48.4	45	108.9 ± 58.7
Thiamin (mg)	0.9	1.8 ± 0.7	1.0	2.2 ± 0.8
Riboflavin (mg)	1.1	2.3 ± 0.9	1.2	2.8 ± 0.9
Niacin (mg)	12	20.6 ± 9.3	13	25.2 ± 10.8
Folate (μg)	75	290.5 ± 174.7	100	352.1 ± 197.5
B_6 (mg)	1.1	1.8 ± 0.9	1.4	2.3 ± 1.1
B_{12} (μg)	1.0	4.9 ± 5.3	1.4	5.3 ± 3.3

Intake data are means ± SD.

mean intake for saturated fat was close to the recommended level, two-thirds or more of the children consumed levels greater than what was recommended.

The current nutrition guidelines developed by ADA (1) do not present recommendations for carbohydrate nor total fat intake as a percentage of the daily energy requirements. However, the NCEP Guidelines (15) suggest an intake of ≤30% of energy from total fat and a carbohydrate intake of ~55% of energy for healthy children and adolescents in an attempt to lower average population levels of blood cholesterol. When the intake of the children in this study is compared with the NCEP guidelines, the mean total fat and carbohydrate intakes approach their recommendations (Table 1). To assess whether individual intakes were appropriate, blood lipid and glucose parameters were needed.

The mean intake of energy, vitamins, and minerals was at or close to recommended levels for both the 4–6- and 7–9-year-old children (Table 2). Both age groups had mean intakes below the recommendations for vitamin D, and the 4–6-year-old children also had a mean intake just below that recommended for zinc. For other vitamins and minerals, mean intake exceeded the recommendations.

Table 3 summarizes the distribution of vitamin and mineral intake for the sample. Intake was at or above the RDA for at least 85% of the children for nearly all vitamins and minerals. However, 10–40% of the sample had levels of intake <77% of RDA for vitamins D and E and for zinc. Fewer of the 7–9-year-old children fell below 77% of the RDA than children 4–6-years of age for these and other nutrients.

CONCLUSIONS — The dietary intakes of 66 children with IDDM aged 4–9 years were examined to assess the adequacy of their diets in relation to the current nutritional recommendations. The data are based on self-reported information. There is evidence that this may result in an underestimation of energy intake (23). Dietary intake based on 24-h dietary recalls, however, have been shown to be less likely to underestimate energy intakes, compared with methods such as food records (24).

Overall, the sample met the recommendations for protein and most vitamins and minerals. The intake of saturated fat exceeded the recommendations (1).

Dietary fiber intake was lower than the recommended 20–35 g per day (1); however, the values were higher than those reported in nationwide surveys conducted by the U.S. Department of Agriculture and the National Center for Health Statistics (25,26). For age-matched children, both the Nationwide Food Consumption Survey and the Third National Health and Nutrition Examination Survey reported fiber intakes of 9–12 g per day. In light of these findings, intervention may have been initiated to encourage an increased carbohydrate content of the diet, especially from fiber-containing complex carbohydrate sources. However, the latest recommendation for carbohydrate intake does not stress a set percentage of energy coming from carbohydrate. The amount of dietary carbohydrate may vary and is to be based upon an individual's eating habits and his or her specific glucose and lipid goals.

Guidelines have been established for children >2 years of age regarding fat intake to decrease the risk of cardiovascular disease (15). Further, IDDM has been associated with an increased risk of cardiovascular disease (11–13). We observed intake levels for fat and saturated fat close to the recommendations (1,15). This may not be surprising given that national trend

Table 3—*Distribution of vitamin and mineral intake*

Nutrient	4–6 years of age (n = 27) <77% RDA	4–6 years of age (n = 27) 77–100% RDA	4–6 years of age (n = 27) ≥100% RDA	7–9 years of age (n = 39) <77% RDA	7–9 years of age (n = 39) 77–100% RDA	7–9 years of age (n = 39) ≥100% RDA
Calcium	7.4	7.4	85.2	2.6	2.6	94.9
Iron	3.7	18.5	77.8	2.6	7.7	89.7
Phosphorous	0.0	3.7	96.3	0.0	2.6	97.4
Zinc	18.5	29.6	51.9	10.3	20.5	69.2
Vitamin A	3.7	3.7	92.6	2.6	10.3	87.2
Vitamin E	22.2	33.3	44.4	12.8	25.6	61.5
Vitamin D	40.7	33.3	25.9	28.2	38.5	33.3
Vitamin C	3.7	7.4	88.9	2.6	0.0	97.4
Thiamin	0.0	0.0	100.0	0.0	0.0	100.0
Riboflavin	0.0	3.7	96.3	0.0	2.6	97.4
Niacin	0.0	7.4	92.6	0.0	2.6	97.4
Folate	0.0	0.0	100.0	0.0	0.0	100.0
B_6	3.7	3.7	92.6	2.6	12.8	84.6
B_{12}	0.0	0.0	100.0	0.0	0.0	100.0

Data are percentages of samples. Percentages of RDA are based on 1989 RDA.

data (25,26) show that the intake of fat, as a percentage of energy, by children is declining. However, many children in our sample consumed levels well above the recommended intake for fat and saturated fat (1,15). Thus, these children may be at even greater risk of cardiovascular disease than the general population.

It appears that the protein content of the diet is well managed in these children, with intake levels meeting the recommendations. Of possible concern is that the majority of children had intake levels reaching the upper limit of the recommendations. Studies have shown that clearly one-third of patients with IDDM will develop nephropathy within 15–20 years after diagnosis (27,28). However, the progression of renal disease may be slowed or reversed by a low protein diet (29,30).

The intake of vitamins and minerals in the overall sample were reported to be adequate, with the intake of most vitamins and minerals exceeding the RDA. Alemzadeh et al. (19) reported similar findings in their study of children with IDDM. With the exception of vitamin C, the mean intake of vitamins and minerals exceeded those reported in the third National Health and Nutrition Examination Survey for the general population of children in this age group (26).

For vitamins D and E and zinc, we report inadequate intakes by many of the children in the sample. These same nutrients were reported to be consumed at low levels by hypercholesterolemic children of the same age (31). Similarly, vitamin E and zinc (vitamin D intake not reported) were also found to be nutrients of concern in the diets of a nationwide sample of children (32). The nutrient intake data in this and nationwide surveys is derived from food alone. Future studies should examine specific supplements used and their contribution to total nutrient intake.

In conclusion, this sample of children with IDDM had overall dietary intakes that reflected or were close to the current nutritional recommendations for, for example, cholesterol and protein. However, many individual children had diets that were not consistent with the recommendations. Nutrition education strategies need to concentrate on increasing the complex carbohydrate composition of the diet and reducing dietary fat and saturated fat while maintaining an adequate intake of vitamins and minerals, especially vitamins D and E and zinc. Given the importance of dietary management and the scarcity of dietary intake data on children with IDDM, this paper contributes to the knowledge of how well current dietary recommendations are being followed. Future studies should be designed to determine some of the food selection factors that may contribute to the prevalence of the high intake of saturated fat and the low intake of certain vitamins and minerals by some children with IDDM. Future studies to examine the relationship between carbohydrate intake and glucose goals would provide additional useful information.

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