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Are children with Type 1 Diabetes consuming a healthful diet? A review of the current evidence and strategies for dietary change

Abstract

Purpose—The purpose of this study is to review the literature on usual dietary intake in children with type 1 diabetes (T1D) and to discuss approaches to promote dietary change with potential efficacy.

Methods—Search strategies included a MEDLINE search for English-language articles that estimated usual dietary intake in children with T1D and a screening of the reference lists from original studies. The keywords used were: *diet, dietary intake, nutrition, type 1 diabetes, children, adolescents, and youth*. Studies were included if they were observational, contained a sample of children with T1D, and estimated usual dietary intake.

Results—Nine studies fulfilled the criteria (6 US, 3 European). Of the four studies with a control group, 3 reported that both total fat and saturated fat intake were higher in the children with T1D. Six studies examined the percent of total calories from saturated fat; mean intake ranged from 11%–15%, exceeding ADA recommendations (< 7%). Fruit, vegetable and fiber intakes were low among children with T1D. No prior studies have addressed dietary change in this population. The behavior-change literature suggests that nutrition education alone is unlikely to be adequate, but that incorporation of behavioral approaches offers potential efficacy in promoting healthful dietary change.

Conclusions—Children with T1D are not meeting dietary guidelines, and in some areas their diets are less healthful diets than children without diabetes. As these dietary behaviors may affect the risk of long-term complications, the incorporation of behavioral approaches promoting healthy eating into routine clinical practice is warranted.

Introduction

Medical nutrition therapy (MNT) for children with type 1 diabetes (T1D) emerged in the 1990's^{1,2} and is an essential component of disease management. The goals of MNT are to keep blood glucose levels near normal, to avoid both acute and long term diabetes-related complications and to support normal growth and development.³ The American Diabetes Association's (ADA) current nutrition recommendations focus on matching the insulin dose to the grams of carbohydrates consumed.⁴ The coordination of carbohydrate intake and insulin administration is emphasized in order to achieve near-normal glycemia since tighter glycemic control reduces the risk of microvascular complications in individuals with diabetes.⁵

Dietary management of T1D has changed dramatically in recent years. Modern therapies, including the insulin pump and flexible injection regimens, have resulted in less restrictive dietary regimens, allowing children with T1D to lead more normal lifestyles.^{6,7} Therefore, the ADA now recommends individualized meal planning based on food preferences, culture, physical activity patterns, family eating patterns and schedules.⁴ Thus, today most children with T1D are able to eat what they want and do not have to time meals carefully or limit certain foods. Although flexible insulin regimens have decreased restrictive timing and consistency of food consumption, they also may have made it easier for children with T1D to eat unhealthful foods. For example, according to current dietary management of diabetes, children do not have to limit the amount of refined sweets consumed as long as they are included in their daily

carbohydrate allowance and their glycemic targets are achieved. In addition, use of processed foods may be appealing to facilitate ease of carbohydrate counting. Nevertheless, healthful dietary practices are particularly important for children with diabetes due to their increased risk of dyslipidemia and cardiovascular disease.

There is no research supporting differing nutrient needs for children with T1D compared to children without diabetes.³ Therefore, children with T1D, like all children, should follow the 2005 Dietary Guidelines for Americans (Table 1) and consume a diet that emphasizes fruits, vegetables, whole grains, and low-fat milk while limiting intake of less-nutrient-dense foods.⁸ Total fat intake should be 30% to 35% of calories for children 2 to 3 years of age, and 25% to 35% of calories for children 4 to 18 years of age. In addition, the ADA recommends that saturated fat intake should be less than 7% of total calories.⁴ A diet emphasizing a wide variety of healthful foods and not just one that limit sugars and other carbohydrates is now recommended for children with T1D.

Children with T1D and their families may hold misconceptions about what constitutes a healthful diet for diabetes management. In a recent qualitative study of 140 youths with T1D ages 7 to 16 years age discordance was demonstrated between what the youths thought were generally healthful foods and what foods they thought were good for managing their diabetes.⁹ Youths correctly described overall healthful eating practices primarily in terms of eating fruits, vegetables and low-fat foods. However, many youths reported that “free” foods high in total fat, cholesterol and saturated fat (such as cheese, bacon, steak) were good choices for their diabetes management since these foods do not contain carbohydrates. There is some evidence that such perceptions translate into actual dietary practices. The SEARCH for Diabetes in Youth study reported higher than recommended amounts of total fat and saturated fat in the diets of children with T1D¹⁰; however, this study did not have a healthy control group, so it is unknown whether this dietary pattern is representative of children in general or specific to those with T1D. Yet other smaller studies have found that children with T1D do consume more total fat and saturated fat compared to healthy children.^{11,12}

The purpose of this study is to review the literature on usual dietary intake in children with type 1 diabetes (T1D) and to discuss approaches to promote dietary change that have potential efficacy.

Part 1: Usual dietary intake in children with T1D

Methods

Inclusion/Exclusion Criteria—Studies were included in this review if they fulfilled the following *a priori* defined set of criteria: (1) contains a sample of children with type 1 diabetes, (2) estimates usual dietary intake and (3) is an observational study. Studies that combined children with type 1 and type 2 diabetes and reported the results in aggregate, those that included subjects with another chronic disease (i.e. celiac disease), or those that did not specify the type of diabetes were excluded.

Search of Studies—Search strategies included (1) a computerized MEDLINE search for English-language articles that examined usual dietary intake in children with type 1 diabetes and (2) a screening of the reference lists from all original studies. The following keywords were used: *diet, dietary intake, nutrition, type 1 diabetes, children, adolescents and youth.*

Literature Search—Fifteen studies were identified, and nine fulfilled the inclusion/exclusion criteria (Table 2).^{10–18} Six studies were excluded for the following reasons: the type of diabetes wasn't reported (n=3), the study was conducted in a camp setting in which usual dietary intake may not have been represented (n=1), the subjects had concomitant celiac disease

(n=1) and the dietary data for subjects with type 1 and type 2 diabetes were reported in aggregate (n=1). Of the nine studies, six were from the US and three were from Europe (Norway, Sweden and Finland). Only one of the studies was a large, multi-center study (SEARCH for Diabetes in Youth)¹⁰; the rest were relatively small studies from single geographic locations. Only one study was longitudinal. In addition, several different methods were used to estimate usual dietary intake, including food records, food diaries, 24 hour recalls, food frequency questionnaires and diet histories.

Results

Macronutrients—Although all of the studies examined dietary intake in children with T1D, only 4 of the 9 studies had a control group of healthy children for comparison.^{11,12,14,17} Of those 4 studies, 3 reported that the children with T1D consumed more total fat and saturated fat and less carbohydrates than the healthy children.^{11,12,14} Only 1 study of young children (< 6 years of age) with newly diagnosed T1D in Finland reported that children with T1D consumed less fat and more carbohydrates than the healthy children.¹⁷ That study examined dietary intake 3, 12, and 24 months after diagnosis and found that the macronutrient composition of the diet changed over time. From 3 months to 24 months the proportion of total calories from carbohydrates decreased (54 to 52%), total fat increased (26% to 30%) and saturated fat increased (9% to 11%). Six of the studies examined the percent of total calories consumed from saturated fat; mean intake ranged from 11–15%, exceeding the ADA recommendation of < 7%.^{10–12,15,17,18}

Fruits/Vegetables—Three of the studies quantified fruit and vegetable intake and found that typical consumption was well below recommendations.^{10,12,17} The SEARCH study was the only US study to report the number of servings of fruits and vegetables consumed and the percentage of children meeting recommendations.¹⁰ Both the younger (10–14 years) and older (> 15 years) age groups consumed 1.3 ± 1.1 servings of fruit per day. The estimated servings per day of vegetables were 1.5 ± 1.2 in the younger age group and 1.8 ± 1.4 in the older age group. Only 20.0% of the younger children and 17.9% of the older children met fruit recommendations and even fewer met vegetable recommendations (9.9% and 15.2% respectively).

Two of the European studies reported fruit and vegetable intake. Overby and colleagues reported that intake of fruits and vegetables among children with T1D was 210 g/day which was similar to the intake in healthy children but well below the recommendations of 500 g/day.¹² Virtanen and colleagues assessed fruit and vegetable intake (g/1000 kcal) longitudinally at 3, 12 and 24 months after diagnosis. Intake of both fruits (199g, 186g, 177g) and vegetables (168g, 146 g, 120 g) declined over time in children with T1D.

Dairy/Milk—Three of the studies quantified dairy or milk consumption.^{10,12,17} In the US, the SEARCH study reported that the estimated servings per day of dairy were 2.0 ± 1.2 in the younger children and 1.7 ± 1.1 in the older children. Although the authors didn't report the percent of children who met dairy recommendations, they did report that 63.2% of the younger children and 54.9% of the older children met calcium recommendations. In Norway, Overby and colleagues reported intake from full fat, low fat and skimmed milk.¹² The largest quantity of milk consumed was low fat milk, with an average intake of 185 g/day for the 9–10 year olds and 174 g/day for the 12–13 year olds. In addition, dairy products (milk, cheese and butter) provided 48% of the saturated fat intake in the diet. In Finland, Virtanen reported that children with T1D derived 20% of total calories from milk/milk products vs. 30% in the healthy children.¹⁷ In addition milk/milk product consumption decreased from 3 months to 24 months after diagnosis (419 g/1000 kcal to 380 g/1000 kcal).

Whole Grains/ Dietary Fiber—The SEARCH study was the only study that reported whole grain intake, and none of the children met recommendations for whole grain intake (≥ 3 servings/day).¹⁰ Six of the studies reported fiber intake and the findings consistently demonstrated that fiber intake was low (12 to 21 g of fiber per day) and well below the recommended amount.^{10–12,15,17,18}

Part 2: Behavioral approaches for promoting dietary change

The present review identified no studies that tested behavioral approaches to improve dietary intake in children with T1D. Therefore in this section we review approaches that have potential efficacy in promoting dietary change in children and therefore offer utility for use by diabetes educators to address the nutritional inadequacies documented in the literature reviewed above.

Nutrition Education

Nutrition education is currently an important component of standard diabetes care. The focus of nutrition education for children with T1D and their families is on optimizing metabolic control through dietary choices.³ Findings from this review suggest that diabetes educators should emphasize that the nutrition recommendations for children with T1D are the same as those for all children and that they should consume sufficient servings of fruits, vegetables, fiber, whole grains and low-fat dairy.⁸ In addition, special attention should be given to fat and saturated fat recommendations for children with T1D since they are at increased risk for cardiovascular disease, and there is evidence that atherosclerosis can be well-established by adolescence.^{19,20}

Although knowing how and why to eat healthfully is important, knowledge alone does not enable children to do so.²¹ It is well-documented that nutrition knowledge is necessary but not sufficient for dietary change which is why education-only approaches are not typically successful.²² A meta-analysis of studies in children and adults found a very weak association between nutrition knowledge and dietary behaviors ($r=0.10$).²³

A randomized study was conducted in Australia using a nutrition education approach to examine the effect of a low glycemic index (GI) diet versus carbohydrate exchange diets on dietary intake and glycemic control in 104 children with T1D.²⁴ Both groups received similarly structured diet education sessions, but differing in content. A flip chart was used to explain the principles of the study and literature was provided to both groups. At 12 months there were no significant differences in any of the dietary variables but the low GI group had slightly better HbA1c than those in the carbohydrate exchange group ($8.05 \pm 0.95\%$ vs. 8.61 ± 1.37 , $p=0.05$). While the study was not designed to test the effect of nutrition education per se, the findings indicate that the education provided did not achieve the differential dietary intake targeted, suggesting that strategies beyond nutrition education are needed to effectively change dietary behavior.

Behavioral modification—Compared with knowledge-based programs, nutrition programs that have a behavioral focus tend to be more successful in producing dietary change.²² Behavioral modification strategies address the social-environmental antecedents and consequences of behavior, altering behavior by shaping these contingencies and/or by facilitating the development of more adaptive responses to them. For example, the likelihood of desirable behaviors may be increased by providing reinforcement for them. Behavioral modification techniques for children and their parents have been successfully used to promote dietary change in children with cystic fibrosis^{25,26}, juvenile rheumatoid arthritis²⁷, Crohn's disease²⁸ and obesity.²⁹ Including the entire family is extremely important since parents are a major influence on their children's eating behaviors both by providing the food and by helping to shape food attitudes, preferences and values through their own eating behavior and through

parenting strategies regarding eating. Studies have demonstrated that parent's eating behaviors and the home food environment (i.e. accessibility and availability of foods) are important determinant of children's dietary intake.^{30,31} Therefore the likelihood of children making positive changes to their diets will be increased if their parents are involved and supportive.

Following are behavioral modification techniques successfully employed in previous nutrition interventions.

1. **Self-monitoring of dietary intake-** Keeping a record of dietary intake increases awareness of and attention to this behavior. Further, by analyzing and summarizing the records, the child (and parents) can be provided with easily understandable information about his/her current diet and what areas need improvement. Graphs often work well for providing feedback on what a child is eating compared to more optimal dietary intake.
2. **Problem solving skills-** Problem solving skills are particularly important when environmental antecedents and consequences operate counter to the desired behavior. For example, the widespread availability of unhealthy food is a powerful antecedent to unhealthy eating. Problem solving skills can help the child identify antecedents that promote unhealthy eating and find ways to ensure healthier responses. They can also help parents identify barriers to providing healthy meals and find ways to overcome these obstacles. Problem solving methods generally involve helping the child and parent determine recurring problem situations, generate possible adaptive responses, evaluate these options, select the best option or options, and evaluate the results of their choice.
3. **Goal setting-** Behaviorchange is facilitated by setting concrete, manageable, observable goals. The process of goal setting may increase motivation and direct specific effort toward the desired change. Goals should be solicited from the child, rather than being imposed upon him/her. After setting concrete dietary goals (e.g., eat 5 serving of fruits a day) the child monitors his/her progress (e.g., places stickers on a chart if daily goal is met). Goals may be progressive in nature, beginning with modest goals and progressing toward a more optimal diet. In addition to the child setting goals, it is also useful for parents to set goals (e.g., having the child's favorite fruit in the house and making sure that it's readily accessible) which will help to ensure that the child can achieve his/her goals.
4. **Reinforcement-** When positive consequences follow a behavior that behavior is more likely to occur in the future. Attention to reinforcement in dietary change is particularly important, as many unhealthy foods are highly palatable and therefore highly reinforcing. Positive reinforcement may take the form of praise or tangible rewards. The parent and child decide upon rewards for meeting his/her goals. The reward is only given if the goals are met. Motivating rewards for children include playing a game, going to a movie, staying up a little later at night, having extra time to talk on the phone or using the computer. Typically, tangible rewards are important for initiating behavior change. As the behavior becomes more habitual, self-reinforcement (i.e., self-praise) and intrinsic motivation (e.g., valuing healthy eating) can replace tangible rewards.
5. **Differential attention-** A form of reinforcement, differential attention involves positively reinforcing desired behaviors and ignoring undesired behaviors. For example, parents or caregivers are taught to praise the child for trying a new fruit but ignore comments about dislike of the vegetable served.

An advantage of behavioral modification is that the child and the parents have very specific, well-defined goals and the child is rewarded with positive feedback if the goals are achieved.

Dietary recommendations that are global with little discussion of specific strategies for changing and maintaining the diet generally do not work.³² Further, behavioral modification incorporates the teaching of skills that facilitate the child's ability to engage in the desired behavior. The disadvantage of this approach is that it can be time consuming to teach and to implement. Parents also have to be willing to withhold rewards from their child if the goals are not met because behavioral modification will not be successful with inconsistent rewards. In addition, attention should be given to the maintenance of the behavior change so that it does not remain dependent on parent-provided rewards.

Motivational interviewing—Motivational interviewing (MI) is a newer technique that has recently emerged as a promising model for health promotion and disease management.^{33,34} It was initially used to address addictive or compulsive behaviors but more recently has been used to promote dietary change behavior.^{35,36} Motivational interviewing is “a directive, client-centered counseling style for eliciting behavior change by helping clients to explore and resolve ambivalence”.³⁴ Motivation to change is elicited from the individual, and not imposed from the diabetes educator. This technique offers a practical approach for helping individuals increase their motivation or “readiness” to change and may be especially appropriate for adolescents or teenagers since it provides opportunities to increase their sense of autonomy. There is much less data on the use of MI to promote dietary change in children compared to the behavior modification literature. However MI was used in a study of adolescents with hypercholesterolemia and was acceptable to the participants and viewed effective by the interventionists.³⁷

Following are key principles in Motivational Interviewing.

1. **Express Empathy**- This involves seeing the world through the child's eyes (e.g., “It must be difficult with all of things that you have to do to manage your diabetes every day to also pay attention to eating healthier.”).
2. **Support Self-Efficacy**- The belief that change is possible is an important motivator to succeeding in making a change (e.g., “You've made some great changes to improve your health in the past and I am confident that you can also make some changes to eat healthier.”).
3. **Roll with Resistance**- Statements demonstrating resistance are not challenged. Instead the diabetes educator uses the child's "momentum" to further explore his/her views (e.g., “I can understand why you are hesitant to make any changes in how you eat. However, if you did decide to make a change what would it be like?”).
4. **Develop Discrepancy**- The diabetes educator helps the child examine the discrepancies between their current behavior and future goals. When individuals perceive that their current behaviors are not leading toward some important future goal, they become more motivated to make important life change (“You talked about how important basketball is to you. Might your eating habits make a difference in how well you play?”).

The advantage of MI is that it is a very individualized technique that allows the diabetes educator to be empathetic and work with the child no matter how ready he or she is to make a change. It allows the diabetes educator and the child to work in partnership with each other rather than at odds with each other. It opens the door for communication and allows for personal autonomy, which is why it may be particularly useful for adolescents and teenagers. The greatest challenge with this approach is that it may run counter to the more traditional mode of communication in health care practice, and so development and maintenance of skilful MI requires training and practice. Further, MI is a relatively new method in the field of nutrition; although there is some evidence that it may be successful, data regarding its efficacy is limited.

DISCUSSION

The recent literature suggests that children with T1D are not meeting the current dietary recommendations to consume sufficient fruits, vegetables, whole grains, and low-fat milk while limiting intake of less-nutrient-dense foods. Unfortunately these unhealthful dietary patterns are not unique to children with T1D; many healthy children's diets also fall well below recommendations for several food groups and nutrients.^{38,39} The USDA's Continuing Food Survey examined the diets of 3,307 US youths (ages 2 to 19); the percentage meeting recommendations ranged from 30% for fruits, grains, meat and dairy to 36% for vegetables. In addition, 16% met no recommendation, and only 1% met all. Therefore, the unhealthful dietary habits of children with T1D are at least in part a reflection of the diet of the broader population.

However, with regard to fat intake, the diets of children with T1D are actually poorer than among children without diabetes. In the studies with comparison groups, both total fat and saturated fat consumption were higher in children with T1D compared to healthy children.^{11,12,14} It is plausible that a focus on carbohydrate counting may shift the diet toward greater consumption of foods that do not contain carbohydrate, either to avoid additional insulin administration or in an effort to avoid blood sugar excursions. However, common lower carbohydrate foods in the U.S. diet are also high in total fat, cholesterol and saturated fat. In a recent qualitative study children with T1D reported that foods including cheese, bacon and steak were good choices for their diabetes management since they do not contain carbohydrates.⁹ Therefore, diabetes educators need to emphasize that consumption of carbohydrate from healthful whole foods does not need to be limited, that plant-based foods such as nuts and avocados are healthier low carbohydrate choices, and that a diet high in saturated fat and cholesterol may lead to cardiovascular disease.

It is unclear whether and how the diets of children with T1D change after diagnosis since longitudinal dietary intake data are lacking. Only one study from Finland examined dietary intake in young children shortly after diagnosis and then 24 months later.¹⁷ Both fruit and vegetable intake declined over time and dietary fat and egg consumption increased. However, there were no longitudinal data from the comparison group so it is not possible to determine whether this trend can be attributed to the disease. Diabetes regimens are incredibly demanding so it is possible that other aspects of disease management compete with eating healthfully. Given these issues, it is important for diabetes educators to help families find ways to facilitate healthful eating while also managing other diabetes related management tasks.

Diabetes educators may experience frustration when addressing the issue of healthful eating, as dietary advice provided may not be followed. Due to environmental, physiological, cultural, and social factors, dietary behavior change is difficult and often met with some ambivalence or resistance. Nutrition education is recognized as necessary, but insufficient as the sole strategy to address the complex factors that influence dietary behaviors. While some highly motivated and skilled families will only require the provision of education to facilitate healthful dietary change, most families need will assistance in surmounting individual, social, and environmental barriers to dietary change. Behavioral approaches that increase motivation and promote skill development for both the child and family increase the likelihood of achieving meaningful and sustained change. Although no literature exists on behavioral nutrition interventions to improve dietary intake in children with T1D there is evidence that the approaches reviewed are effective in other pediatric populations²⁶⁻²⁹, and therefore offer promise for application to families of children with T1D. Given the current poor dietary intake of children with T1D and the potential of dietary behavior to impact both current glycemic control as well as risk for future complications, the incorporation of behavioral approaches promoting healthy eating into routine clinical practice is warranted.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1**2005 Dietary Guidelines for Americans dietary recommendations for children***

Food group/NutrientRecommendations	
Fruits/Vegetables	Two cups of fruit and 2 1/2 cups of vegetables per day for a reference 2,000 calorie intake (higher or lower amounts required depending on calorie levels). A variety should be consumed, in particular consumption from 5 vegetable subgroups (dark green, orange, legumes, starchy vegetables and other vegetables) should be emphasized.
Dairy	Children 2 to 8 years of age should consume 2 cups of fat-free or low-fat milk or equivalent milk products per day. Children 9 years and older should consume 3 cups per day.
Whole grains	Whole grain products should be consumed often, and at least half the grains consumed should be whole.
Carbohydrates	Consume sufficient amounts of fiber by consuming whole fruits, vegetables and whole grains. Avoid excessive amounts of calories from added sugars.
Fat	Total fat intake should be between 30 to 35% of calories for children 2–3 years of age and between 25–35% for 4 to 18 year olds. Intake of fats and oil high in saturated and/or trans fatty acids should be limited. Most fats should come from sources of polyunsaturated and monounsaturated fatty acids.

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Reference 8

Table 2

Studies of usual dietary intake in children with type 1 diabetes

Author	Year	Location	Sample	Ages	Dietary Assessment Method	Results
Overby NC	2007	Norway	177 children with T1D9–10 and 1,809 children without diabetes	10 and 12–13 years old	Four day pre-coded food diaries	Energy intake was similar for children with and without diabetes. Children with diabetes consumed 33–35% of calories from fat (14–15% saturated fat). They also consumed more total fat and saturated fat than healthy children which was higher the recommended amounts for their age. Fruit and vegetable intake was low in both groups. Children consumed 53% of calories from carbs, 34% from fat and 13% from protein. Less than half met the DRI for calcium and all but 1 child met the DRI for B12.
Patton SR et al	2007	US Ohio	33 children with T1D	2 and 8 years of age	Three day diet diaries	Males with T1D and without consumed similar amounts of calories. However males with T1D consumed more total fat (115 vs. 90 g) and saturated fat (40 g vs. 30 g) than healthy males. They consumed fewer carbohydrates (296 g vs. 411 g). Females with T1D and without also consumed similar calories. The females with T1D also consumed more total fat (78 g vs. 54 g) and saturated fat (27 vs. 18 g) than healthy females. Their carbohydrate intake was also lower (238 g vs. 305 g). Intakes were examined separately for ages 10 to 14 and > 15 years. Depending on age group the percent of energy was 37% to 38% for fat, 48–49% from carbohydrates and 16% for protein. Less than 15% met ADA or AHA recommendations for total and saturated fat intake. In addition intake of fruits, vegetables and grains were inadequate.
Faulkner S	2006	US Illinois	50 children with T1D and 53 children without diabetes	T1D 13.0 to 18.9 years	Three 24 hour recalls	Children with diabetes consumed a greater proportion of calories from protein and fat and a smaller proportion of calories from carbohydrates than adolescents without diabetes. Male with diabetes consumed substantially
Mayer-Davis EJ	2006	6 study centers in US (OH, CO, IL, WA, SC, HI, CA)	1511 children with T1D	10 to 22 years	SEARCH Food Frequency Questionnaire*	
Helgeson VS et al	2006	US Pennsylvania	132 children with T1D and 131 children without diabetes	5th to 7th graders	Three 24-h recall interviews	

Author	Year	Location	Sample	Ages	Dietary Assessment Method	Results
Lodefalk M	2006	Sweden	38 children with T1D	13 to 19 years	4-day food record	more saturated fat than the other groups. Males consumed 53% of calories from carbohydrates, 31% from fat and 17% from protein. Females consumed 54% of calories from carbohydrates, 30% from fat and 16% from protein. Both males and females consumed 13% of fat calories from saturated fat. Nutrient composition was examined separately by insulin regimens. Those on continuous subcutaneous insulin infusion consumed 49.3% of calories from carbohydrates, 16.2% from protein and 34.4% from fat. Children on traditional insulin therapy consumed 51.4% of calories from carbohydrates, 15.7% from protein and 32.7% from fat.
Wilson MA et al	2003	US Illinois	28 children with T1D	11 to 16 years	Diet history from medical charts	Over all, children with T1D consumed less fat (28% vs. 35%), more carbohydrates (53% vs. 50%) and more protein (19% vs. 15%) than children without diabetes. In addition, the quality of dietary fat was in accordance with recommendations with saturated fat around 10% of total energy.
Virtanen S	2000	Finland	33 children with T1D < 6 years of age and 66 children without diabetes		5 day food records for children with T1D and 30 day food records for healthy children	Children consumed 53% of calories from carbohydrates and 32% from fat. The mean intake of saturated fat (11.4 + 3.1% of calories) was above the recommended amount and many of the children consumed levels well above the recommendations. In addition, mean dietary fiber was 16.6 + 6.5 g which is lower than the recommended 20–25 g/day.
Randecker et al	1996	US Pennsylvania	66 children with T1D	4 to 10 years	Three 24-h recall interviews	

* Modified from the Block FFQ