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ISPAD GUIDELINES

ISPAD Clinical Practice Consensus Guidelines 2022: Nutritional management in children and adolescents with diabetes

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1 | WHAT IS NEW OR DIFFERENT

- The guide to the distribution of macronutrients has been updated and reinforces family preferences and healthy eating patterns
- Food security should be assessed, and advice adapted to the resources of the family
- Consider insulin prescribing and dose adjustment by dieticians where health settings allow
- Continuous glucose monitoring (CGM) is a useful tool for educating both the clinician and young person with diabetes on food related behaviors and the impact of specific meals on glucose levels

2 | EXECUTIVE SUMMARY AND RECOMMENDATIONS

- Nutrition therapy is recommended for all young people with diabetes. Nutritional advice needs to be adapted to cultural, ethnic, and family traditions, as well as the cognitive and psychosocial circumstances of the young person and their family. **E**
- Implementation of an individualized meal plan with prandial insulin adjustments improves glycemic outcomes. **A**
- Dietary recommendations are based on healthy eating principles suitable for all young people and families with the aim of improving diabetes outcomes and reducing cardiovascular risk. **E**
- It is recommended that a specialist dietician with experience in pediatric diabetes is part of the multidisciplinary team and available as soon as possible at diagnosis to develop a consistent relationship with the young persons with diabetes and their families. **E**
- Energy intake and essential nutrients should aim to maintain ideal body weight, optimal growth and development and help to prevent acute and chronic complications. Regular monitoring of height, weight, and body mass index (BMI) is required to identify both excessive weight gain and failure to grow normally. **C**
- The optimal macronutrient distribution varies depending on an individualized assessment of the young person. As a *guide*, carbohydrate should approximate 40–50% of energy, fat <35% of energy (saturated fat <10%), and protein 15%–25% of energy. **C**
- Matching of insulin dose to carbohydrate intake on intensive insulin regimens allows greater flexibility in carbohydrate intake and mealtimes, with improvements in glycemia and quality of life. **A**
- Meal-time routines and dietary quality are important to achieve optimal glycemic targets. **B**
- Fixed insulin regimens require consistency in carbohydrate amount and timing for optimal glycemic targets and to reduce the risk of hypoglycemia. **C**

- Pre-prandial insulin dosing should be encouraged from the diabetes onset for young people of all ages. **A**
- Carbohydrate counting is best introduced at onset of type 1 diabetes (T1D) along with education about the impact of mixed meals on postprandial glucose profiles. **E**
- There are several methods of quantifying carbohydrate intake (gram increments, 10–12 g carbohydrate portions and 15 g carbohydrate exchanges). There is no strong evidence to suggest that one method is superior to another. **E**
- The use of the glycemic index provides additional benefit to glycemic management over that observed when total carbohydrate is considered alone. **B**
- Dietary fat and protein affect early and delayed postprandial glycemia. **A** Changes to both the insulin dose and pattern of delivery are needed for meals higher in protein and fat. **A**
- Prevention of overweight and obesity in young people with diabetes is a key management strategy and should be based on a family-oriented approach. **B**
- Repeated episodes of diabetic ketoacidosis (DKA) or worsening glycemic outcomes may be a sign of disordered eating. **C**
- Nutritional advice on how to successfully manage both regular and unanticipated physical activity; and how to meet individual goals in competitive sports is recommended. **E**
- Nutritional management of type 2 diabetes (T2D) requires a family and community approach to address the fundamental problems of excessive weight gain, lack of physical activity and the increased risk of cardiovascular disease (CVD). **E**

3 | INTRODUCTION

Nutritional management is one of the cornerstones of diabetes care and education. Different countries and regions have widely varying cultures and socio-economic statuses that influence and dominate dietary habits. Although there is strong evidence for nutritional requirements in young people, the scientific evidence base for many aspects of diabetes dietary management is still emerging and it is important to individualize nutrition interventions and meal plans.

These consensus guidelines are an update from 2018 that reflect national and international pediatric position/consensus statements[1–4] and, whilst considerations of evidence derived from recommendations for adults with diabetes[5,6] are included, this chapter is aimed at the pediatric and adolescent population. Nutritional advice for young adults (18–24 years) should be based on the adult nutrition recommendations.[5–7]

Dietary recommendations for young people with diabetes are based on population healthy eating recommendations[1,4] and therefore suitable for the whole family. Nutritional advice must be adapted to cultural, ethnic, and family traditions and the psychosocial needs of the individual young person. Regardless of economic status, consideration should be given to food security. Likewise, the choice of insulin regimen, where possible, should account for the dietary habits and lifestyle of the young person.

A pediatric specialist diabetes dietitian should be available wherever possible as part of a pediatric multidisciplinary diabetes care team to provide education, monitoring and support to the young person with diabetes, parents, carers, extended family, nursery, schoolteachers, and babysitters.[8,9] Access to qualified nutrition professionals varies across the world. Recognized qualifications may be in nutrition and/or dietetics. The definition of a dietician according to the international confederation of dieticians is "a person with a qualification in nutrition and dietetics recognized by national authority(s). The dietician applies the science of nutrition to the feeding and education of groups of people and individuals in health and disease." There is currently no information on the number of children living with diabetes who do not have access to a qualified nutrition professional. There are limited data on the impact of access to qualified nutrition professionals in children with diabetes. Data from adult care[10,11] and other long-term conditions[12] support the effectiveness of qualified dieticians and nutrition professionals as part of multidisciplinary care teams.

The dietician should advise on planning, content, and the timing of snacks/meals in the context of each child's individual circumstances, lifestyle, and the insulin action profile of the prescribed regimen. The extended role of the dietician can include adjustment of insulin doses and other medications and, where qualifications are available in countries, prescribing of insulin and other medications. Non-medical prescribing by allied health professionals has been shown to be safe, improve satisfaction, and access to timely advice across a range of long-term conditions.[13,14]

Nutrition therapy, when used in combination with other components of diabetes care, can improve clinical and metabolic outcomes.[15] Nutritional education and lifestyle counseling should be adapted to individual needs and delivered in a person-centered manner. Education can be delivered both to the child/young person and family and in small group settings. It is important that the whole family is involved in making appropriate changes based on healthy eating principles. Regular mealtimes and routines where the child and family sit down and eat together, helps to establish better eating practices and monitoring of food intake and has been shown to be associated with better glycemic outcomes.[16,17]

The impact of diabetes on eating behavior and the potential for psychological disturbances cannot be underestimated. Education should include behavior change approaches, motivational interviewing and/or counseling and should be regularly reviewed to meet the constantly changing needs of the developing child. In order to be most effective, the dietician needs to develop a consistent, trusting and supportive relationship with the families concerned[18,19] and also have clear agreed goals with the multidisciplinary team.[20]

These recommendations target healthy eating principles, glycemic management, the reduction of cardiovascular risk factors, the maintenance of psychosocial well-being, and family dynamics. Use of these recommendations should acknowledge the impact of food security on the ability to follow treatment guidelines.

4 | GUIDELINES ON NUTRITION FOR HEALTH, GROWTH, AND DEVELOPMENT

4.1 | Energy balance

All young people need access to adequate amounts of good quality food that provides sufficient energy to support their growth and development and to maintain a healthy body weight.[21]

When a child or young person is diagnosed with diabetes, a specialist pediatric dietician should assess the food intake and eating patterns of each family and offer advice to help them develop a routine meal plan that meets their child's nutritional needs and provides adequate energy for an active lifestyle.[3,4,8] Young people living with food insecurity (FI), should be offered strategies to alleviate the challenges and stresses experienced which make achieving dietary recommendations for diabetes difficult.[22]

Energy requirements change with growth and regular reviews of their food intake, particularly in younger children, are essential so families can retain flexibility with their meal plans.[4,23] Energy prediction equations are a useful guide to estimate energy requirements in young people, however, these calculations must be individually tailored to an eating plan that is achievable and nutritionally adequate.[24] Regular dietary reviews also help families understand how to adjust total energy intakes with changes in age and stage of development, to promote optimal growth, and avoid restrictive diets[25] or over-nutrition that can lead to excess weight gain.[26]

Many young people experience acute weight loss prior to the diagnosis of T1D, followed by an increased appetite soon after initiation of insulin replacement, and this can lead to rapid weight gain if not monitored closely.[27,28] The first year following diabetes onset is a critical period to avoid substantial weight gain and promote maintenance of a healthy body weight over the longer term.[29]

Nutrition education to guide families toward food and drink choices that reflect a balanced energy-appropriate diet will help restore body weight to a healthy range and achieve target glucose levels early on.[3,4]

Total energy intake and appetite can change significantly leading up to (and during) puberty, and this is an important time to routinely reassess individual's nutritional requirements and habitual eating patterns and to consider screening for disordered eating behaviors.[30,31]

4.2 | Maintenance of healthy body weight

Achieving and maintaining a healthy body weight is an important goal in the clinical management of diabetes in young people.[32] The prevalence of overweight and obesity in youth with T1D is at least as high as the general population.[33,34] Global trends in childhood obesity are multifactorial and related to changes in food intake, decreased physical activity, and the obesogenic environment; all contributing to a positive energy imbalance in recent decades.[35] For young people with diabetes other possible causes of obesity include over-insulinization, excess energy intake to avoid or treat hypoglycemia, and additional carbohydrate consumed for exercise.

Diabetes teams can provide family-based guidance on modifiable lifestyle factors such as nutrition, physical activity, and healthy sleep behaviors at diagnosis and on an ongoing basis. At each clinic visit, families can expect that the child/young person will have their height and weight measured, BMI calculated, and growth monitored using appropriate growth charts, to identify any significant changes in weight or failure to grow.[4] Waist circumference and waist/height ratios are less commonly measured in clinic but may be a more useful predictor than BMI of metabolic or cardiovascular risk in some population groups.[34,36]

Dietary review with a specialist pediatric diabetes dietician is recommended for advice to prevent excess weight gain and how to adjust energy intake to support maintenance of a health body weight. Regular review of insulin requirements as children grow can minimize the need for large snacks between meals or before bed to prevent hypoglycemia. Similarly, adjustment of insulin in preference to intake of additional carbohydrate to prevent hypoglycemia during physical activity is recommended.[37]

The use of CGM can be a useful tool to assess amounts of carbohydrate needed to treat hypoglycemia and avoid overtreatment with additional snacks that can contribute to weight gain. The impact automated insulin delivery systems may have on the risk of weight gain in youth with T1D is yet unknown. Healthy food choices in appropriate portion sizes in line with population recommendations are likely to remain a key recommendation.

4.3 | Energy intake recommendations

National guidelines for young people and adults and children with diabetes exist in many countries. Some, including those from Australia and Canada, recommend a carbohydrate intake of at least 45% energy[1,6]; whereas others, such as the UK or US adult recommendations, do not include an amount of carbohydrate expressed as a percentage of energy intake. Clinical consensus is that carbohydrate intakes in older, overweight, or obese adolescents may be lower (40% energy) with higher protein intakes (25% energy).

A guide to the distribution of macronutrients according to total daily energy intake is shown in Box 1.

BOX 1 Macronutrients according to total daily energy intake

- Carbohydrate 40%–50% energy
- Moderate sucrose intake (up to 10% total energy)
- Fat 30%–40% energy
- <10% saturated fat + trans fatty acids
- Protein 15%–25% Energy

BOX 2 Carbohydrate calculation for 7-year-old female with normal activity levels (25th centile weight and height)

DRV	40% Energy as carbohydrate	50% Energy as Carbohydrate	Calculated energy expenditure	40% Energy as carbohydrate	50% Energy as carbohydrate
1703 Kcal/day	170 g/day	212 g/day	1292 kcal/day	129 g/day	161 g/day

These reflect guidelines for healthy eating for young people without diabetes.[38,39] They are also based on food group servings to meet vitamin, mineral, and fiber recommendations for age, without supplementation. An optimal percentage of energy from macronutrients has not been defined and individual and family preferences should be considered.[15] This may vary depending on meal patterns, cultural influences, and metabolic priorities. Restricted access to food may require adjustment of the contribution of carbohydrate to total energy intake to 60% to achieve an adequate intake of other micronutrients and vitamins. Dietary patterns that restrict intake from one macronutrient may compromise growth and lead to nutritional deficiencies.[40]

Translation of the distribution of macronutrients is dependent on the estimation of total energy requirements. Dietary reference values (DRV) are guides for populations[40,41] and individual estimation of energy requirements will ensure appropriate advice is provided. Use of the DRV/daily reference intake (DRI) for energy may result in recommendations to over- or under-consume macronutrients. For example, a calculation for a 7-year-old female with normal activity levels, on the 25th percentile for weight and height versus use of a UK DRV is shown in Box 2.

5 | FOOD COMPONENTS

5.1 | Carbohydrates

Carbohydrate requirements are individually determined based on age, gender, activity, and previous intake. Clinical evidence suggests that individuals can consume 40%–50% energy from carbohydrate and achieve optimal postprandial glycemic targets with appropriately matched insulin to carbohydrate (ICR) ratios and insulin delivery. Healthy sources of carbohydrate foods such as whole grain breads and cereals, legumes (peas, beans, and lentils), fruit, vegetables, and low-fat dairy products (full fat in children under 2 years) should be encouraged to minimize glycemic excursions and improve dietary quality.

5.1.1 | Low carbohydrate diets

There is increasing interest in utilizing low carbohydrate (<26% energy from carbohydrate)[42] and very low carbohydrate (20–50 g/day) diets as an adjunct treatment option for people with T1D.[42,43] Currently, scientific evidence is lacking to support the practice of very low carbohydrate diets or excessive carbohydrate restriction in young people with T1D. Strict adherence to very low carbohydrate diets may result in ketonemia or ketosis, dyslipidemia, and disordered eating behaviors.[40] There is evidence from ketogenic diets that very low carbohydrate diets can be nutritionally inadequate and result in growth failure.[44] Restricted carbohydrate diets may increase the risk of hypoglycemia or potentially impair the effect of glucagon for treatment of severe hypoglycemia.[45]

Whether or not carbohydrate restriction is associated with better health outcomes in young people with T1D is not well-studied. Dietary intake studies in young people using intensive insulin therapy have previously reported an association between lower total carbohydrate intakes and less favorable glycemic outcomes.[46] However, other studies suggest lower daily intake of carbohydrate is associated with lower HbA1c.[47] Current research in the field suffers from the problem of selection and reporting bias as most data come from those families/individuals who choose to follow carbohydrate restricted diets rather than from clinical trials. Clearly, further research is needed to explore potential metabolic and glycemic benefits from moderate carbohydrate restriction in the management of diabetes.

While there is insufficient evidence to recommend very low carbohydrate diets in young people with diabetes, it is important to respectfully explore the reasons families may choose to implement carbohydrate restriction. The perception of what a carbohydrate restriction entails differs among families and diabetes care providers. An emphasis should be on maintaining positive relationships between the family and treating team. If an individual child or family chooses to routinely consume a moderately low (<40% energy) or low (<26% energy) carbohydrate diet they should discuss this with a dietician to ensure the diet is nutritionally complete, particularly in regard to calcium, B vitamins, iron and fiber.[40]

A specialist pediatric dietician will be able to complete a detailed dietary assessment with the family to understand the degree of carbohydrate restriction, discuss the risks associated with restrictive diets in children and adolescents, including eating disorders (ED),[48] and offer a range of strategies the family can use to ensure their goals align with their child's medical needs.[8] Regardless of the amount of carbohydrate in the diet, caregivers and young people with diabetes require strategies to minimize the postprandial excursions caused by carbohydrate. Early preprandial insulin administration up to 15–20 min before the meal[49] or the addition of a moderate amount of protein to a meal containing predominantly carbohydrate[50] can assist in reducing postprandial excursions. Substituting low glycemic index (GI) for high GI carbohydrate[51,52] and increasing dietary fiber intake[46] are other useful dietary options.

A meal-time routine with limits on snacking episodes can assist in preventing prolonged periods of postprandial hyperglycemia.[17]

5.1.2 | Sucrose

Sucrose and sucrose-containing food and fluids should be consumed in the context of a healthy diet.[53] Sucrose does not increase glycemia more than isocaloric amounts of starch.[54] However, consumption of foods containing added sucrose should be minimized to avoid displacing nutrient-dense food choices and decreasing dietary quality. If added, sucrose should be appropriately balanced against insulin doses. Sucrose can provide up to 10% of total daily energy intake. Not all countries have a specific recommendation on the percentage of sugar or mono- or disaccharides in the diet.

Sucrose sweetened beverage consumption has been associated with excessive weight gain.[55] Large quantities of sugary beverages cause high postprandial glucose peaks that are difficult to adequately cover with insulin. The consumption of sweetened drinks, soft drinks and cordials should be discouraged for the whole family. Diet or light drinks can be recommended for children with diabetes instead of sugary drinks on special occasions. Sucrose may be used instead of glucose to prevent or treat hypoglycemia.[56,57] See ISPAD 2022 Consensus Guideline Chapter 11 on Management of Hypoglycemia in children and adolescents with diabetes for more details.

5.2 | Fibers

There are wide variations in recommendations and intakes of fiber internationally,[58] and amounts may be expressed as grams/kilocalorie (g/kcal) or grams/day (g/d). Recommendations are often made for adults; children and adolescents are expected to achieve a percentage of the adult recommendations. Reported intakes of fiber are often lower than recommended and vary geographically. Where available, national population guidelines on fiber intake should be followed where no guidance exists the followinFiber recommendations can be used (Box 3).

BOX 3 Fiber recommendations

Age	Fiber recommendations
Birth through 1 year	Not determined
1 year or greater	14 g/4184 kJ (1000 kcals) or 3.3 g/mJ
Alternative formula	
Children >2 years old[59]	Age in years + 5 = gm of fiber per day

Intake of a variety of fiber-containing foods such as legumes, fruit, vegetables, and whole grain cereals should be encouraged. Soluble fiber in vegetables, legumes and fruit may be particularly useful in helping to reduce lipid levels.[60] Processed foods tend to be lower in fiber; therefore, unprocessed, fresh whole foods should be encouraged. Dietary fiber intakes of children in many countries are lower than recommended.[59]

Dietary fiber is associated with digestive health and modulates bowel function, fermentation, and has effects on gut microbiota.[61] Dietary fiber aids in laxation and should be increased slowly to prevent abdominal discomfort and should be accompanied by an increase in fluid intake.[61]

Diet high in whole grains may help to improve satiety, replace more energy dense foods and prevent weight gain.[62] Increasing fiber intake can assist in improving glycemic outcomes,[46] and reducing CVD risk.

5.3 | Fats

Population based nutritional guidelines recommend a fat intake of no greater than 30%–40% total daily energy intake.[25] The American Heart Association supports children consuming a healthy diet which limits saturated fat and recommends replacement with polyunsaturated and monounsaturated fat to reduce CVD risk in later life.[63]

High total fat intakes increase the risk of overweight and obesity[25] and high saturated and trans-fat intakes have been associated with an increased risk of CVD.[1] Studies show that young people with diabetes consume fat and saturated fat above dietary recommendations.[64]

The aim of nutritional advice in clinical practice is to ensure saturated fat, trans fatty acid and total fat intakes do not exceed recommendations for the general population. Monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) can be used as substitutes to improve the lipid profile.[5] Eating patterns that resemble the Mediterranean diet (based on monounsaturated fats, wholegrain carbohydrate, plant-based food choices with a reduced intake of red and processed meats) are likely to be of benefit to long-term health and reduction of CVD risk.[65,66] Care should be taken when giving dietary education that methods of quantifying carbohydrate do not increase total fat and/or saturated fat intake.

- Recommendations for saturated and trans fatty acids should be in line with those for the general population. No more than 10% energy from saturated fat is recommended.[7] Saturated fat is the principal dietary determinant of plasma LDL cholesterol. Saturated fats are found in full fat dairy products, fatty meats, and high fat snacks. Trans fatty acids, formed when vegetable oils are processed and solidified (hydrogenation), are found in margarines, deep-frying fat, cooking fat, and manufactured products such as cookies and cakes. Trans fat should be limited as much as possible.

- Replace saturated fat with unsaturated fats by using lean meats, fish, low fat dairy products and changing to cooking oils and margarines from MUFA and PUFA sources.
- MUFA (particularly cis configuration), found in olive, sesame and rapeseed oils, nuts, and peanut butter may be beneficial in managing lipid levels and confer some protection against CVD. They are recommended replacements for saturated fats.[63]
- PUFA derived from vegetable origins such as corn, sunflower, safflower, and soybean or from oily marine fish may assist in the reduction of lipid levels when substituted for saturated fat.
- Consumption of oily fish rich in n-3 fatty acids is recommended. Advice for children is to eat oily fish once or twice weekly in amounts of 80–120 gm.[67]
- n-3 supplements or an increase in the intake of oily fish should be considered if triglyceride levels are elevated.
- The use of plant sterol and stanol esters (in margarine and dairy products) may be considered for children 5 years and older if total and/or LDL cholesterol remains elevated.[68]

5.4 | Protein

Protein intake decreases during childhood and adolescence from approximately 2 g/kg/day in early infancy to 1 g/kg/day for a 10 years-old and to 0.8–0.9 g/kg/day in later adolescence.[69] Protein promotes growth only when sufficient total energy is available.

Worldwide intake of protein varies greatly depending on economy and availability.

High protein drink and food supplements are generally unnecessary for children with diabetes. Their use requires dietary review with individualized advice.

Sources of vegetable protein such as legumes should be encouraged. Recommended sources of animal protein include fish, lean cuts of meat and low fat dairy products.[1]

When persistent albuminuria, decreased glomerular filtration rate or established nephropathy occurs, excessive protein intake (>25% energy) should be avoided. It is prudent to advise that intake should be at the lower end of the recommended range for age.[70] However, there is insufficient evidence to restrict protein intake. Any modifications to protein intake in adolescence should not interfere with normal growth and requires expert management by a dietician.

5.5 | Vitamins, minerals, and antioxidants

Young people with diabetes have the same vitamin and mineral requirements as other healthy peers.[1] There is no clear evidence of benefit from vitamin or mineral supplementation in children and adolescents with diabetes who do not have underlying deficiencies.[3] Meal planning should optimize food choices to meet recommended dietary allowance/dietary reference intake for all micronutrients. Medical nutrition therapy visits with a dietician are recommended to ensure the child or adolescents' diet is nutritionally complete.

5.6 | Sodium

Young people with diabetes should limit their sodium intake to the recommendations for the general population. Guidelines for sodium intake in children 1–3 years: 1000 mg/day (2.5 g salt/ day); 4–8 years: 1200 mg/day (3 g salt/day); 9 years and older: 1500 mg/day (3.8 g salt/day). High dietary sodium intake in young people with T1D is common and relates to vascular dysfunction.[51]

5.7 | Alcohol and substance use

In young people with T1D, drinking alcohol can contribute to a range of additional health risks, including hypoglycemia and/or hyperglycemia, making them more vulnerable to alcohol-related harms than youth without diabetes.[71] Consequences of alcohol consumption in T1D can include moderate or severe hypoglycemia due to suppression of gluconeogenesis, impaired growth hormone response, alcohol-induced hypoglycemia unawareness, and increased risk of delayed hypoglycemia for 8–12 h after drinking alcohol.[72] Hyperglycemia is another consequence that can be related to drinking and occurs when consuming alcoholic beverages that are high in sugar, or by consuming additional carbohydrate before and after drinking to prevent hypoglycemia.[71,73]

In many countries there are strict limits on the minimum legal age required for the purchase of alcohol, but not always the same level of regulation on alcohol consumption. Alcohol is prohibited in many societies, however where there is exposure to alcohol, studies show adolescents and young adults with T1D have similar or slightly lower rates of participation in drinking alcohol compared to their peers without diabetes.[74,75] For those youth and families who have chosen to include alcohol in their lifestyle, encourage people to ask questions and raise awareness about the negative impact drinking alcohol can have in the short-term on glucose levels and on the long-term on cardiovascular disease (CVD) risk.[76] It is important for pediatric diabetes teams and families to talk with young people about alcohol, and to discuss the facts so that young people are supported to make better choices about drinking. These conversations can be part of a program of education that prepares adolescents for transition to adult services[77] or at any time there is a need identified to reduce the harm of alcohol and substance use.[73,78]

- Young people should be aware of the guidelines for sensible drinking for adults and understand that alcohol consumption is not recommended for children and adolescents.[79]
- Education is needed on the alcohol content of different drinks and what defines a standard drink.
- Carbohydrate should be eaten before and/or during and/or after consuming alcohol. It may be also necessary to decrease the insulin dose, particularly if young people are physically active (e.g., dancing and walking) at the time that they are drinking.
- Young people should be aware there are different types of alcoholic drinks available and understand how these drinks might

impact glucose levels; for example, some drinks contain carbohydrates and can cause initial hyperglycemia, but the alcohol content contributes to risk of delayed hypoglycemia.

- Advice should include avoidance of binge drinking (more than four standard drinks) and young people should be given practical suggestions to reduce alcohol intake if they are exposed over long periods of time, such as having low alcohol drinks or alternating between non-alcoholic sugar-free drinks (including water) and drinks containing alcohol. Low carbohydrate or 'diabetic' beers should be viewed with caution as many do not have reduced alcohol content.
- Alcohol intake in young people may lead to increased risk-taking behaviors and interfere with the ability to recognize hypoglycemia symptoms. It is important to carry diabetes identification and always have quick-acting carbohydrate treatment options available.
- Drinking alcohol can be a risk factor in young people not following their usual diabetes self-care routine, such as checking glucose levels, eating regular meals, adjusting their insulin with physical activity and, as a result, their glucose levels can become unpredictable.[80]
- Excessive amounts of alcohol can cause vomiting and dehydration which can lead to diabetic ketoacidosis (DKA) and hospitalization.[80,81]
- Special care should be taken to prevent nocturnal hypoglycemia by having a carbohydrate snack at bedtime and monitoring glucose levels more often than usual during the night and the following day, at least until lunchtime.[72] CGM can also be very helpful in preventing nocturnal hypoglycemia.
- The health implications of using of cannabis and other substances (including tobacco, vaping and illicit drugs) should be discussed with adolescents and emerging young adults with diabetes as part of their routine care.[78] Cannabis use is associated with changes in appetite and eating behaviors, inconsistent glucose monitoring and insulin administration[73,82] and increased risk of DKA among adults with T1D.[83]

5.8 | Non-nutritive sweeteners and specially labeled foods for people with diabetes

Non-nutritive sweeteners provide insignificant amounts of energy and elicit a sweet sensation without increasing blood glucose or insulin concentrations. FDA-approved sweeteners are safe when consumed within FDA acceptable daily intake amounts (ADI). These are listed in Box 4.

All these FDA approved non-nutritive sweeteners are used in low sugar, "light" or "diet" products to improve sweetness and palatability.

- Country specific guidelines on the intake of sweeteners may exist that should be followed.
- International nutritional guidelines advise that a moderate amount of sucrose can be consumed by people with diabetes[1,5] and foods labeled as suitable for people with diabetes are not necessary. These foods can be more expensive due to the cost of the ingredients, may be high in fat and may contain sweeteners with laxative effects such as polyols (sugar alcohols).
- Polyols (sorbitol, mannitol, erythritol, xylitol, D-tagatose, isomaltose, maltitol, lactitol, and trehalose) are used as sweeteners and bulking agents, are generally recognized as safe by the FDA.[84] Polyols are only partially absorbed from the small intestine, allowing for the claim of reduced energy per gram. Polyols can cause diarrhea at ≥20 gm, especially in children. Some people may be much more sensitive to polyols in smaller amounts.

BOX 4 Acceptable daily intake of non-nutritive sweeteners

Non-nutritive sweetener	Acceptable daily intake (ADI)*
Sucralose	0–15 mg/kg body weight
Saccharin	0–5 mg/kg body weight
Acesulfame K	0–15 mg/kg body weight
Aspartame	0-40 mg/kg body weight
Steviol glycosides (expressed as steviol)	0–4 mg/kg body weight
Monk fruit/Luo Han Guo	Not specified

* https://apps.who.int/food-additives-contaminants-jecfa-database/

6 | FOOD SECURITY

Food security is an important social determinant of health.[85] Food security in a household exists when "all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life."[86]

FI is the limitation in the accessibility and/or the lack of resources for nutritionally adequate and safe foods to support normal growth due to household-level economic and social conditions.[87]

In 2019, an estimated 135 million people faced life-threatening FI, according to the World Food Program. Currently, that number has risen to nearly double due to the coronavirus pandemic, with food emergencies afflicting countries that have not required interventions in the past.[88]

Food security should be considered when applying the guidance in this chapter in clinical practice. The impact of FI was seen to be higher in young people and adults with T1D than in those without diabetes.[89] FI increases the risk of less diverse and lower quality diets, reduced micronutrient intake, iron deficiency anemia, and low intake of fruits and vegetables.[90]

The challenges of diabetes management are increased for families facing FI and the associated risks are amplified in children with diabetes, where nutrition plays a vital role in management.[22] Limited budgets lead to purchasing cheaper, energy dense foods, inexpensive poor-quality carbohydrates (refined grains and added sugars), lower nutrient dense foods which may increase dietary glycemic load, and therefore, worsen glycemic outcomes.[91,92] A study conducted in Jordan reported that individuals with diabetes who were severely food-insecure had a significantly higher average BMI, even though they consumed fewer calories than mildly food-insecure or food-secure individuals leading to the "obesity-hunger paradox."[93]

FI can be cyclic and episodic. This pattern of recurrent exposure to inadequate food may result in disordered eating, in particular binge-fast cycles. The cyclic nature of FI may therefore not only result in binge eating behaviors but may also interact with stress pathways that promote obesity.[94,95]

Nutritional counseling for food insecure young people with diabetes should be tailored to fit their incomes and living circumstances. Healthcare providers must try to understand the challenges that may hinder an individual's ability to follow nutrition advice and consider the available resources for purchasing, preparing, and cooking food. Advice to shift dietary intake away from inexpensive carbohydrates and fats and toward vegetables, fruits, protein, and dairy products while acknowledging limited budgets should be given. Discussing portion sizes of food items that are culturally preferable and acceptable to the people with diabetes and their families may be as important as recommending foods that are affordable. Identifying resources within neighborhoods may be a helpful strategy. The kitchen garden concept (growing vegetables in the backyard/terrace) may be appropriate in some settings.[96] Nutrition counseling should include a discussion of how to achieve healthier diets within the means of the family.

7 | GUIDELINES FOR NUTRITIONAL CARE, EDUCATION, AND MEAL PLANNING

Initial dietary advice by a pediatric diabetes dietician should be provided as soon as possible after diagnosis to promote a secure, trusting, and supportive relationship.[2,19] A dietary history should be taken including:

- Pre-existing family dietary habits, traditions, and beliefs
- The child's usual food intake including energy, carbohydrate amount and distribution, fat intake, quality of food choices and mealtimes or patterns of food intake
- The child's daily activities including the impact of nursery/school/work, physical activity, and exercise schedules

Advice should be given at diagnosis based on the dietician's assessment and the individualized plan provided by the diabetes team. Carbohydrate counting is best commenced at diagnosis for those using intensive insulin therapies.[3]

A series of follow-up appointments should be completed with the specialist pediatric dietician within 3–6 months after diagnosis with the first consultation within a month after diagnosis.[97] It is important that the initial assessment includes identification of any body image or weight concerns. Contacts thereafter depend on local arrangements, a minimum should include 2–4 times in the first year and an annual reassessment thereafter.[97] These are necessary to keep pace with the child's growth, modifications to the insulin regimen, lifestyle changes and the identification of specific dietary problems such as dysfunctional eating habits, family issues around food, obesity and EDs. Ongoing support and review by a dietician is essential for optimal care.[3] Frequency of review will be impacted by factors such as changing insulin regimen, mode of insulin delivery, dyslipidemia, need for age-appropriate education, weight gain or weight loss. Co-morbidities such as celiac disease require extra education and dietary intervention with more frequent review.

8 | EDUCATION TOOLS, METHODS, AND INSULIN REGIMENS

Education tools and methods are used to provide knowledge and skills to optimize glycemic management, growth, and CVD outcomes.

- Methods of healthy eating education and tools for carbohydrate quantification are essential.
- Basic dietary education should cover healthy eating with some method of carbohydrate quantification.
- Blood glucose monitoring (pre and postprandial) or CGM provide essential information on postprandial glucose excursions and can direct the education needed, which may be a need to improve carbohydrate counting accuracy, adjustment of prandial insulin timing or amount, or alter the insulin delivery (e.g., a combination bolus) or dose for meals high in fat and protein.[98]
- As families become more confident with managing diabetes, education should be responsive to their observations with whole food education used to explain glycemic index, mixed meal impacts and adjustment of insulin.
- Delivery of education may be face to face, group or virtual. The use of telehealth and virtual consultations may help promote self-care and glucose management and improve access to nutrition education and advice.[99]

8.1 | Healthy eating education tools

Country specific education tools exist for population specific healthy eating education across the world. The Plate Model method (Figure 1) is one example that can be useful in providing basic nutritional information and healthy eating concepts. The plate can be thought of as a

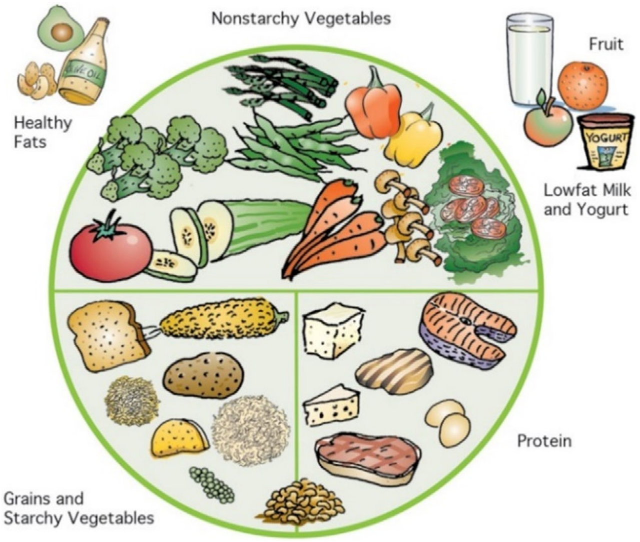

FIGURE 1 Joslin Diabetes Center Healthy Plate Copyright © 2021 by Joslin Diabetes Center (www.joslin.org). All rights reserved. Reprinted with permission

guide to both the individual meal and the whole day. It provides a visual illustration of carbohydrate-containing foods in relation to other food components and is an attractive aid for visual learners. As part of healthy eating education regular meals with small snacks if needed are encouraged to ensure that a range of nutrients are consumed to meet daily recommended requirements.[100]

8.2 | Carbohydrate assessment and methods

The amount of carbohydrate and premeal insulin bolus is one of the most important factors influencing postprandial glycemic levels.[53,101] Other dietary variables such as glycemic index, fat, protein, and fiber impact postprandial glycemia and should be considered when providing education, as well as when interpreting and optimizing postprandial glucose levels.[102,103]

Extensive diabetes education materials are available in many countries to help with the estimation of the carbohydrate content of foods in grams, portions, or exchanges. This approach is usually described as carbohydrate counting. Education sessions involve teaching how to read and interpret food labels, assess the carbohydrate content of the snack/meal, and understand the nutrient content of foods to make healthy choices. Many national diabetes associations also produce useful literature on how to read food labels and count carbohydrate. Education on carbohydrate can improve glycemic outcomes and increase flexibility in food choices.[104] Carbohydrate counting should be part of team-based management approach that includes healthy eating principles and meal-time routines.[23] Information about dietary quality should be provided as part of the education as poor dietary quality has been widely described in young people living with T1D.[105,106]

8.3 | Dietary recommendations for specific insulin regimens

8.3.1 | Twice daily insulin regimens

Twice daily insulin regimens of short- and longer-acting insulin require day-to-day consistency in carbohydrate intake (often as three regular meals with snacks between meals) to match the insulin action profile and prevent hypoglycemia during periods of peak insulin action.[107] Most twice daily insulin regimens require carbohydrate intake before bed to prevent nocturnal hypoglycemia. When other options are available, these insulin regimens should not be used in young people with T1D.

8.3.2 | Intensive insulin regimens

A more flexible approach using individualized insulin to carbohydrate ratios (ICR), which enables the pre-prandial insulin dose to be matched to carbohydrate intake, should be used for children and adolescents on intensive insulin therapy. To assess the accuracy of the ICR, information about postprandial glucose profile is required. Although this method increases flexibility of meal timing and carbohydrate amounts, mealtime routines and dietary quality remain important. International consensus is that carbohydrate counting is best introduced at the onset of diabetes for those using intensive insulin therapy (see ISPAD 2022 consensus guidelines Chapter 9 on Insulin therapy).

Two systematic reviews, based mainly on studies in adults, have reported positive trends in glycemia and lifestyle benefits when carbohydrate counting is used as an intervention for people with T1D.[108,109] These benefits include better HbA1c levels, diabetes-specific quality of life and coping ability in daily life.[109,110]

8.4 | Insulin to carbohydrate ratios

ICRs are used to determine insulin doses based on amounts of carbohydrate. The ICR is individualized for each child according to age, sex, pubertal status, duration of diagnosis, and physical activity. This approach has been endorsed by several international clinical consensus guidelines.[1,3,53] In younger children using CSII, lower percentage basal insulin contribution is effective for achieving high proportion of time in range,[111] and lower total basal insulin will usually result in the use of relatively more bolus insulin for meals, i.e., "stronger" ICRs. A number of formulas using total daily dose for calculation of ICR have been proposed; however, formulas such as the 500 rule initially used in adults can result in "weak" ICRs in children.[112] Younger children often require a "stronger" ICR relative to the total daily dose (i.e., 250 or 330 rules). (See ISPAD 2022 Consensus guidelines Chapter 9 on Insulin therapy). Breakfast may also require a "stronger" ICR than other meals. When assessing ICR the meal composition and the timing of the insulin delivery should also be considered.[113] The postprandial glucose response in the first hour is most likely due to the timing of

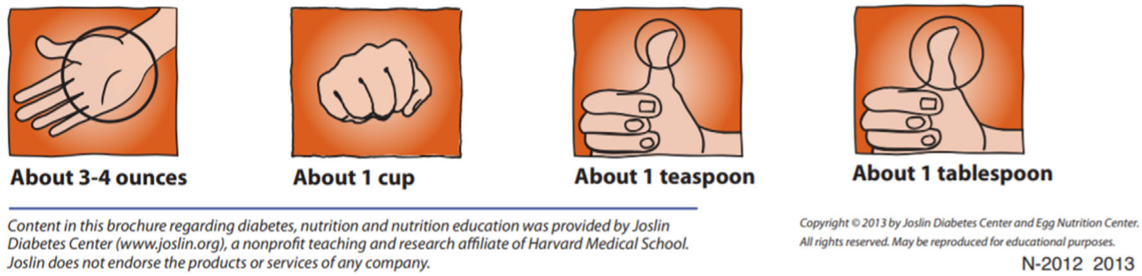

FIGURE 2 Hand measures to estimate amount of food

the insulin, between 90 min and 2 h the predominant factor is probably the amount and GI of the carbohydrate in the meal, and thereafter (late postprandial period), the meal composition.

Studies in adults using multiple daily injections (MDI) with ICRs have shown improvements in dietary freedom, glycemic outcomes, and quality of life,[110] particularly if delivered as part of a comprehensive education package. ICRs have also been evaluated in children and adolescents using MDI, often as part of structured education programs.[114–117]

In a large study of children, adolescents, and young adults, carbohydrate counting was related to better diabetes-specific health related quality of life and optimal glycemic outcomes.[118] A recent small study confirmed improved quality of life associated with advanced carbohydrate counting (ACC) in children.[119]

Research has not demonstrated that one method of teaching carbohydrate counting (grams, portions, or exchanges) is better than any other.[120]

Carbohydrate content of foods can be difficult to assess and there is a need for country and cuisine specific carbohydrate counting resources. ACC requires skills to quantify portion sizes, estimate carbohydrate contents of various foods consumed, read, and understand nutrition labeling on food packages. Access to measuring cups and spoons, food weighing scales, carbohydrate counting resources (pictures, weights, measures of food with carbohydrate counts, nutrition labels, apps, and digital games) are useful tools to learn and estimate the carbohydrate contents of foods.[121,122]

The use of mealtime insulin bolus calculators in both MDI and CSII has been shown to assist insulin dose calculations and potentially improve postprandial glycemia[122–124] and reduce hypoglycemia fear.[125]

Accuracy and consistency in carbohydrate counting are important to optimize postprandial glycemia and reduce glucose variability.[126,127] There is no universal definition for accuracy of carbohydrate counting. Research has shown that children, adolescents and their parents can carbohydrate count with a degree of accuracy, however under and over-estimation of foods remains a challenge.[120] Regular review of carbohydrate counting skills is necessary as children grow and new foods are introduced.[120]

Methods to simplify carbohydrate counting can be used where numeracy and literacy limits the ability of a family to adopt use of grams, portions, and exchanges. The use of the hand size measure is one example. Hand measures (Figure 2) can be used to estimate the amount of food and carbohydrate amount and to teach consistent serving sizes.

9 | GLYCEMIC INDEX AND GLYCEMIC LOAD

The use of the glycemic index (GI) has been shown to provide additional benefit to glycemic management when used in addition to total carbohydrate.[128,129] In T1D, GI should not be used in isolation, but together with a method of carbohydrate quantification.[1] Suggested cut points for classification are high (GI ≥70), medium (GI 56–69), and low (GI ≤55) GI values.

High fiber, low GI foods can help delay the absorption of glucose into the bloodstream, consequently helping to manage blood glucose levels. The GI of a food is influenced by factors such as cooking/preparation method, physical state of a food, type of starch, amount of fat and protein consumed with the food.[130]

A controlled study in children using twice daily insulin, substituting low GI for high GI foods found that a lower GI diet improved glycemic outcomes after 12 months compared to prescriptive dietary advice.[131]

In clinical practice GI is used as a tool to minimize postprandial glucose rises and to improve the quality of the diet.

- Low GI foods may lower postprandial hyperglycemia when they are chosen to replace higher GI foods.[132] This has been demonstrated in a meal study with children using MDI.[51]
- Low GI food sources include whole grain breads, pasta, temperate fruits and dairy products.[133]
- The GI of some foods can differ depending on the geographical location. Dairy products, legumes, pasta, and fruits tend to be low (GIs 55 or less) and are remarkably consistent around the world. Cereals and cereal products, however, including whole grain or whole meal versions, show wide differences, presumably arising from variation in manufacturing methods. Breads, breakfast cereals, rice, and snack products are available in both high- and low-GI versions. Many varieties of potato and rice are high-GI foods, but more low-GI varieties have been identified by research and development.

- Education on GI should incorporate understanding of individual glucose responses to specific foods where information is available from continuous and intermittently scanned glucose monitoring devices.
- The timing and type of insulin delivery may be adjusted depending on the GI of the food. Early delivery of insulin with high GI foods may blunt postprandial glucose spikes and use of a combination type bolus may be beneficial with lower GI foods.[49]

Glycemic load (GL) is another method of predicting the postprandial blood glucose response, which considers both the GI of the food and the carbohydrate portion size.[134] A small pilot study on the feasibility of GL counting in nine adults with T1D found that this method is feasible in real-life for prandial insulin dose calculations.[135] Further studies are needed to investigate the efficacy of GL for calculating the meal-time insulin dose.

10 | MANAGEMENT OF MIXED MEALS

10.1 | Fat and protein

The mealtime insulin dose is typically calculated using an individualized ICR. The impact of fat and protein on postprandial glucose levels has been well established.[103] Observations from pediatric and adult studies have shown that meals high in either protein or fat increase delayed hyperglycemia (up to 3–6 h after the meal) and reduce the early (1–2 h) postprandial rise.[50,136–138] These studies highlight the limitations of carbohydrate-based only formulas for insulin dosage calculations.

Several methods of adjusting insulin doses for fat and protein have been suggested including a formula based on fat protein units (FPU)[139] and the Food Insulin Index (FII) that has been developed and trialed in adults.[140] More practical strategies include making percentage increases in insulin dose based on carbohydrate counting. A higher rate of clinically significant hypoglycemia has been observed in studies using the FPU formula, which is a potential a limitation of this method.[139,141,142] The FII has demonstrated variable outcomes in adult studies.[143,144] A comparison of carbohydrate counting, fat protein units and FII in a pediatric population demonstrated that there was no benefit of FII compared to carbohydrate counting. The FPU formula showed increased postprandial time in range but was associated with an increase in hypoglycemia.[145] Adjusting the original FPU formula may reduce the frequency of hypoglycemia and it has been suggested to consider 200 kcal from protein to require the same amount of insulin as 10 g of carbohydrates.[146]

Management of mixed meals and the impact of fat and protein will depend on the method of insulin delivery and glucose monitoring. Currently most evidence to support optimal insulin bolus dose and delivery for meals high in fat and protein is specific to insulin pump therapy[147]; there are fewer studies to inform management using MDI therapy and hybrid closed loop (HCL) systems.

10.1.1 | CSII

Published systematic reviews of the evidence for insulin dose adjustment for fat and protein provide a range of recommendations, from incremental dose increases up to 30–35% for meals high in fat and protein accompanied by an extended bolus,[49] whereas other reviews suggest increased insulin requirements may range between 25 and 75%, with a starting adjustment of up to 60% dose increase administered 15 minutes before a high protein, high fat meal used with a combination type bolus with the remainder of the dose delivered over 3 hours.[103] However, substantial inter-individual differences exist in insulin dose requirements for fat and protein and individualized advice based on postprandial glucose monitoring up to 6 h is required.[148,149]

10.1.2 | MDI

Data is available from studies showing that additional insulin for high protein and fat meals can be delivered in the pre-prandial injection. Positive outcomes have been reported using a 125% of the calculated insulin dose for carbohydrate content for a high fat and protein breakfast as a pre-prandial injection without adverse outcomes.[150] One study using insulin doses calculated based on carbohydrate, fat and protein content of the meal showed improved postprandial glucose profiles without increased hypoglycemia; in this study the ICR was calculated using a 500-rule based on total daily dose.[151]

- Adjustment of insulin doses for fat and protein should be made when there is evidence of the postprandial impact for the individual. A suggested starting point for additional insulin is a 20% increase in the dose calculated for carbohydrate alone.
- Education on the impact of fat protein is helpful from diagnosis to support understanding of the glycemic impact of mixed meals and foods. Education on assessing postprandial glucose profiles should include understanding of when the raised glucose levels are likely to be due to the timing of insulin delivery (the first 60–90 min), carbohydrate content of the meal/food (90–120 min) fat, protein, and meal composition (120–300+ min).
- Education on the application of evidence of the impact of fat and protein may be beneficial for example, adjusting breakfast content to contain protein to dampen postprandial spike, use of meals higher in protein when delayed hypoglycemia is a risk.

The management of protein and fat in HCL systems is not yet well studied in adults or young people. Clinical experience suggests that individual advice will be needed and some strategies to manage high fat and protein meals may be needed by some people with T1D. To understand the advice that may be needed, the dietician needs to understand how the HCL algorithm adjusts insulin and the bolus options available. The timing of insulin bolus delivery remains important when using an HCL system.[152]

10.2 | Timing and type of insulin boluses

The timing of the prandial bolus is important. Several studies have shown that pre-prandial bolus insulin is preferable to insulin administered during or after the meal.[51,113,153,154] Delivering a bolus dose 15–20 min before eating rather than immediately before improves postprandial glycemia.[113] Newer rapid-acting insulins also require pre-prandial dosing for optimal outcomes. Missed meal boluses negatively impact on glycemic outcomes.[155,156]

One of the advantages of CSII is the ability to tailor prandial insulin delivery to the meal composition. This enables the meal bolus to match the glycemic effect of the meal (low GI, high fat or high protein content).[103]

A systematic review concluded differences in the *duration* and *split* of bolus types across studies, make it difficult to recommend a specific duration and split for *all* meal types.[4949] Studies indicate intra-individual variation in the pattern of insulin delivery required for meals.[103,142] A study in children and adolescents found the optimum combination bolus split to maintain postprandial glycemia with a high-fat and high-protein meal was a 60/40% or 70/30% split delivered over 3 h.[157] However, a study in adults demonstrated the mean optimal pattern of delivery for a high protein, high fat meal was a 30/70% split delivered over 2.4 hours, with a range from 10%/90% to 50%/50% and a delivery duration from 2 to 3 h.[158] Studies have confirmed that the standard bolus is not as effective as the combination bolus for high fat and high protein meals.[157,159] In clinical practice, use of a combination bolus with sufficient insulin upfront to manage the Initial postprandial rise is needed. Initial experience with HCL systems suggests that the timing and delivery of insulin bolus with meals remains central to improved outcomes, with the ICR being one of the settings that the user can adjust.[152]

For those on MDI, it has been suggested from clinical experience at some centers short-acting (regular/soluble) insulin may be given when a prolonged insulin effect is desired. Two studies comparing analog insulin (insulin aspart) and regular insulin have shown no benefit in substituting regular insulin for a faster acting analog.[150,160] Split insulin doses have also been recommended by some centers. One study in adults examining this found that for a high fat, high carbohydrate meal administration of 130% of the prandial insulin dose as a split bolus (100%: 30%), 3 h post meal consumption produced a glycemic response similar to the low-fat (5 g) control condition with no increase in hypoglycemic episodes.[161] When this dose was delivered as a normal bolus however, the incidence of hypoglycemia significantly increased. Pre- and postprandial blood glucose testing at 1, 3, 5, and 7 h or CGM can be useful in guiding insulin adjustments and evaluating the outcomes of changes to the insulin dose or timing.[162]

11 | AGE GROUP SPECIFIC ADVICE

The challenges of nutrition education for young people with diabetes are often age-related and reflect the nutritional and developmental needs of different age groups. Family functioning and interactions at mealtimes have been demonstrated to impact on eating behavior and glycemic outcomes in younger children[163] and adolescents.[164] Below is a summary of the specific characteristics to consider when working with different age groups. See ISPAD 2022 Consensus Guidelines Chapter 23 on Managing Diabetes in Preschool Children and Chapter 21 on Managing Diabetes in Adolescents for more detailed information on the nutritional management in these age groups.

11.1 | Toddler and preschool children

Toddlers have variable appetites. Routine, small meals over the day promote improvements in glycemic outcomes and nutritional adequacy. Grazing on small foods quantities should be discouraged as this may contribute to food refusal at mealtimes and can result in postprandial hyperglycemia. CSII may help manage toddler eating behaviors.[16,165] It is preferable that pre-prandial insulin doses are given,[23] although the dose can be split (a fraction given before and the remainder during the meal) when eating is erratic or new foods are offered.

Positive parental role models and early participation in family meals may promote improved cooperation regarding food and healthy food choices. The re-introduction of a bottle of milk or juice for "easy" carbohydrate intake should be discouraged. Parental anxiety regarding food intake is common in this age group and strategies should be provided for pre-prandial dosing. Daycare providers and babysitters need instruction on diabetes management.

11.1.1 | School-aged children

Diabetes in school

Managing diabetes in a school setting requires a high degree of teamwork, with families, teachers, foodservice providers, non-medical staff, school nurses, and diabetes teams all having an active role to play[166,167] (see ISPAD 2022 Consensus Guidelines Chapter 22 on Management of diabetes in School for more detailed information).

A regular meal and snack plan usually works well in a school environment, although flexibility in the school timetable will be required for children to test glucose levels frequently across the day and be supported to take medications and remedial action to treat hypoglycemia and hyperglycemia as required. Some children will need encouragement to eat their food (and take insulin if required) before going out to play at break times.

Diabetes management plans for each child need to be regularly updated and include information on the child's routine eating plan and management of carbohydrate content of school meals or "lunchbox" food. School staff (including non-medical and school nurses) will require education and support from the family and diabetes team to appropriately supervise children taking insulin before food and apply effective diabetes management strategies.[166,168]

Ongoing education

With supervision and support, the child should start to acquire an age appropriate recognition of carbohydrate foods and understanding of carbohydrate amounts in foods.[120] Advice on healthy food choices, food portion size, and physical activity to reduce the risks of inappropriate weight gain and CVD is important. Although some school-age children are capable of gaining knowledge and skills in carbohydrate counting and glucose monitoring,[120] when arranging playdates, sleepovers and parties, families are encouraged to discuss their child's normal routine for food, physical activity and sleep with other family members and friends, and be available to support their child's diabetes management.

11.2 | Adolescents

Adolescents may choose to be more independent in their food choices and have more freedom on what to eat, when and how much. This can negatively affect their glycemic management and food choices.[169] If adolescents have been diagnosed during their childhood, re-education about the importance of healthy eating, nutrition and diabetes self-management may be needed. Challenging behaviors may include staying out late, sleeping in, skipping insulin, and missing meals and in some cultures, drinking alcohol. Emphasis should be placed on the importance of healthy, routine meals particularly during periods of rapid growth to prevent excessive afternoon or evening snacking. The insulin and meal timing may need to be adapted to suit variable schedules, including school, exercise, and work commitments.

Weight monitoring is recommended for early recognition of either weight loss or inappropriate weight gain. Excessive weight gain requires careful review of insulin dosage, food intake, glycemic management, and physical activity. Weight loss or failure to gain weight may be associated with insulin omission for weight management and may be indicative of a disordered eating behavior(DEB) or an ED. In those with high HbA1c, irrespective of weight profile, further assessment of disordered eating thoughts and behaviors should be considered.

Parties, vacations, peer pressure to eat inappropriately and healthy lifestyle advice all require discussion, problem solving and target setting. Advice on the safe consumption of alcohol and the risk of prolonged hypoglycemia is important in societies where adolescent alcohol consumption is prevalent.

Integrating technology in diabetes care may be attractive to engage adolescents in the decision making of their diabetes and promote healthy behaviors (carbohydrate counting through apps, exercise routines, understanding the impact of different foods in their glucose levels and food diaries).[169]

12 | FESTIVITIES AND SPECIAL EVENTS

Detailed guidance on the management of fasting can be found in the ISPAD 2022 Consensus Guidelines Chapter 24 on Ramadan and other religions fasting.

Special events may include a range of activities including parties, celebrations, and festivities specific to culture and religion. These will all need individual advice and planning according to the insulin regimen.

- Emphasis needs to be placed on the importance of routine with respect to meal timings rather than following an erratic and frequent eating pattern[170]
- Feasting or post fast meals include consumption of high GI foods that also have a high fat, sodium, and calorie content. A nutritional assessment reviewing carbohydrate intake with guidance on making healthy food choices, moderation, portion control, reading nutrition labels, maintaining appropriate energy, adequate hydration and physical activity should be given.
- The principle of carbohydrate, protein and fat counting along with additional insulin and type of bolus (if appropriate) that may be used to manage delayed postprandial blood glucose excursions can be especially useful on these special days. Family involvement and support is crucial in ensuring individual's ability to maintain the diet[96,171,172]
- CGM/frequent self-monitoring of blood glucose (SMBG) can help understand the glucose variability during fasting and feasting. This information can help the health care team in adjusting medications as well as give timely suggestions on meal modification to achieve optimal glycemic outcomes.[173]

13 | NUTRITIONAL MANAGEMENT OF EXERCISE AND PHYSICAL ACTIVITY

Young people with diabetes should be encouraged to participate in regular physical activity because it promotes cardiovascular and mental health and aids weight management. The ISPAD 2022 Consensus Guidelines Chapter 14 on Management of diabetes during exercise provides further detailed explanation of the glycemic impact of physical activity, insulin adjustment strategies and the use of nutrition for hypoglycemia prevention. Adult recommendations on energy balance suggest that participation in general fitness does not necessitate an increase in energy intake above normal recommendations, whereas those who train for >2 h per day will require an increased energy intake.[174,175]

Sports nutrition recommendations for young athletes are adapted from adult recommendations with consideration given to the differences in exercise physiology between young athletes and adults. In T1D further consideration to avoiding hypo- and hyperglycemia is needed. Recommendations that include nutritional intake for adult athletes with T1D are available.[176] Application of these recommendations needs to account for the training or sports regimens, individual glucose responses, and sports aims of the individual athlete.

13.1 | Energy requirements

Energy needs for the young athlete will vary with amount and type of sport being performed. Requirements may be increased above population guidelines and should be calculated on an individual basis. Requirements may be underestimated by predictive equations.

Low energy availability (LEA) and Relative energy deficiency in sports (RED-s) have been demonstrated to be common in certain populations, including female and adolescent athletes.[177] Whilst no studies have been performed specific to T1D, if LEA is associated to low carbohydrate intake, this will probably increase hypoglycemia risk both during and after exercise. Sports with a requirement for specific body types may pose a higher risk for LEA, for example dance, gymnastics, weight making competitive sports. RED-s has many features of disordered eating and specific screening tools exist (although not validated for T1D), which may be useful in identifying areas of concern.

Adequate total nutrition should ensure that increased energy needs of the sport do not impair growth.[178] The type, intensity and duration, as well as the age, sex, and fitness levels need to be accounted for within an individual management plan. Exercise management plans should emphasize the importance of careful planning, individual attention to detail (blood glucose monitoring, food intake and insulin adjustment) and incorporate the personal experiences of the young person. Advice on overall nutritional intake with a focus on carbohydrate, protein, fluid, and micronutrient intake based in the guidelines presented below should be provided (Box 5).

13.2 | Carbohydrate

The primary fuel for muscles for most types of activity is carbohydrate.[178] Advice on carbohydrate intake for sports performance should be distinguished from advice on carbohydrate intake for hypoglycemia prevention. Based on exercise type, additional carbohydrates may require insulin to enhance utilization and sports performance.[179]

BOX 5 Nutrition guidelines for physical exercise

Protein	1.2–1.8 g/kg/day with 20 g shortly after exercise
Carbohydrate	50% of total energy intake across the day or 3–8 g/kg body weight dependent on exercise intensity 30–60 g per h during exercise lasting longer than 60 min 1–1.5 g/kg body weight within 30 min of finishing of session
Fat	No more than 30% energy intake
Fluid	5–7 ml/kg 4 h before exercise During exercise fluid intake sufficient to minimize body mass changes to <2% After exercise sufficient fluid to replace losses 460–675 ml per 0.5 kg weight loss

To meet the demands of training and recovery carbohydrate intake should be distributed across the day. Specific nutrition advice should cover the pre and post exercise periods.

13.2.1 | Pre exercise period

Prior to exercise (1–3 h), a low-fat, carbohydrate containing meal should be consumed to maximize glycogen stores and availability of carbohydrate for exercise. Assessment of body composition should be considered when using guidelines based on body weight. Young athletes with a greater lean mass may have higher requirements than those of the same body weight or BMI with a high body fat mass. Amounts of carbohydrate required will also be impacted by insulin adjustment, hypoglycemia risk is increased when exercise is performed during peak insulin action. The challenges of sport performed within the school day may make this situation unavoidable. Where possible the guidance in the chapter on exercise management should be followed to adjust insulin based on activity type and glucose trajectory to prevent hypo- and hyperglycemia and support sports nutrition goals. For some high intensity strenuous or anaerobic activities, pre-exercise carbohydrate may also require additional bolus insulin.[180] Food consumed prior to competitive sports may require increased insulin doses compared to training situations. CGM can be used to guide both carbohydrate and insulin adjustments for exercise.[181]

13.2.2 | During exercise

Aerobic exercise lasting 60 min or longer may require additional carbohydrate to maintain performance. Additional carbohydrate needed during activity should be distributed across the activity. Isotonic sports drinks containing 6%–8% carbohydrate may be useful during prolonged activity (>1 h) to address both increased fluid and carbohydrate needs.[182] Examples of suitable carbohydrate sources for exercise include carbohydrate gels, isotonic sports drinks, fruit, and fruit juices. Additional carbohydrate during exercise can cause gastrointestinal upset, so advice should be adapted to suit the individual. Carbohydrate ingestion during exercise should be practiced in training.

13.2.3 | Post-exercise

Carbohydrate intake needs to be sufficient to ensure replacement of both muscle and hepatic glycogen stores, and prevent post-exercise hypoglycemia caused by increased insulin sensitivity during muscle recovery.[180] To aid muscle recovery, it is sensible to consume a low fat, protein and carbohydrate containing meal or snack after training. Carbohydrate mixed with protein may be beneficial in the prevention of post-exercise hypoglycemia.[176,183] Post-exercise carbohydrate needs vary with the intensity and duration of exercise but may be as high as 1.5-g/kg bodyweight.[184] Post exercise carbohydrate will require carefully adjusted insulin doses to reduce glycemic excursions.

13.3 | Protein

Protein is needed for muscle protein synthesis and when consumed with carbohydrate post-exercise may enhance muscle glycogen re-synthesis. The amounts of protein needed to support and enhance sports performance for both resistance and endurance exercise is debated in the literature. For the young people with T1D it is unlikely that total protein intake will be inadequate or that requirements are as high as those stated in adult recommendations. Distribution and timing of protein intake is important and advice about suitable foods to be eaten before and after exercise and before sleep should be given. Adult literature suggests that 25–30 g protein per meal is optimal to enhance muscle protein synthesis.[185,186] Ensuring protein is included in the meal prior to exercise may help reduce the risk of hypoglycemia during exercise.[183] Co-ingestion of carbohydrate and protein post-exercise may help attenuate the risk of late onset hypoglycemia. One study using milk as a post-exercise drink in T1D demonstrated reduced nocturnal hypoglycemia when compared with carbohydrate only drinks.[187] Milk based drinks are recommended as appropriate sources of protein and carbohydrate for enhancing muscle protein synthesis in sports nutrition literature.[188] A further advantage of milk is its leucine content as this has been specifically associated with the ability to train, compete, and recover.[189]

13.4 | Fluid

Fluid intake should be maintained at a level appropriate to the activity to maintain optimal hydration (144). A 1% decrease in body mass has been shown to impair performance.[190] Fluid requirements in young people during strenuous exercise are of the magnitude 13 ml/kg/h. Fluid should be consumed throughout the activity.[191] Water is suitable for most activities up to 60 min duration; however, drinks containing 6–8% carbohydrate are useful when additional carbohydrate is required either for sports performance or hypoglycemia prevention.[192]

13.5 | Micronutrients

Young athletes are at risk of micronutrient deficiency particularly iron (especially females), calcium and vitamin D.[193] Review of food intake should include assessment of intake of these nutrients. Monitoring of vitamin D status is recommended due to increased risk in the young athlete. Correction of vitamin D deficiency may be needed for optimal sports performance.

13.6 | Supplements

Sports nutrition uses a food first approach. Evidence from young sports competitors demonstrates a high use of sports supplements and it is likely that young people with T1D will display similar behaviors. In most cases supplements are unnecessary. Popular supplements used by adolescent athletes include protein supplements and creatine.[194] Young athletes may also be interested in the use of caffeine, which may contribute to hypoglycemia prevention.[195] Counseling on how to use food to maximize training adaptions is essential. Guidance on the use of supplements and the evidence to support their use is available.[196] Advice should include information about the risks of supplement use and guidance on anti-doping according to the sport and level of competition.

14 | NUTRITIONAL MANAGEMENT OF TYPE 2 DIABETES IN YOUNG PEOPLE

The aims of nutritional management for young people with T2D are:

- Achieve normal glycemia and HbA1c[15]
- Prevent further weight gain in those with BMI at 85–95th percentile or achieve weight loss for those with BMI >95th percentile whilst maintaining normal linear growth
- Address co-morbidities, such as hypertension and dyslipidemia

There is little evidence regarding the nutritional management of T2D in young people. Therefore, recommendations are derived from the treatment of overweight and obese children, adults with T2D and young people with T1D. Evidence suggests that there is no ideal macronutrient distribution for weight loss and plans should be individualized.[15] There is some evidence that calorie controlled, lower carbohydrate diets may achieve greater reductions in lipid profiles and diabetes medications; and are therefore an effective strategy for the optimization of T2D management.[197]

Most young people with T2D are overweight or obese, therefore treatment should be centered on education and lifestyle interventions to prevent further weight gain or achieve weight loss while maintaining normal linear growth. The entire family should be included in the lifestyle intervention since parents and family members influence the child's food intake and physical activity and they are often overweight or obese and also have diabetes.[198] Families should be counseled to decrease energy intake by focusing on healthy eating, strategies to decrease portion sizes of foods, and lowering the intake of high energy, fat and sugar containing foods. Simply eliminating sugary beverages such as soft drinks and fruit juices can accomplish improvement in blood glucose and weight.

Increasing energy expenditure by increasing daily physical activity to 60 min daily is an important component of treatment.[199] Limiting sedentary behaviors, such as television viewing, video games, and computer use has been shown to be an effective way to increase daily physical activity and help maintain or achieve a healthy weight in children. Physical activity may also help lower lipids in adolescents with diabetes.[200]

Medical nutrition therapy should be provided to prevent and treat co-morbidities including obesity, dyslipidemia, hypertension, and micro- and macro-vascular complications.[2]

Very low-calorie ketogenic (VLCK) diets can be safely and effectively used in the management of young adults with T2D.[201] Clinical experience suggests obese older adolescents with T2D may also benefit from a carefully monitored VLCK weight loss program.[202]

15 | MANAGEMENT OF CO-MORBIDITIES

15.1 | Dyslipidemia

Dyslipidemia is often overlooked or inadequately treated in young people with diabetes, even though CVD remains a major cause of mortality in adults with diabetes.[203] Hyperglycemia, insulin deficiency and insulin resistance are associated with dyslipidemia, thus the initial therapy should be to optimize glucose management. The management of dyslipidemia requires a comprehensive approach, which includes attention to medical nutrition therapy (Box 6).[2,204]

If dyslipidemia persists despite these measures or in the face of multiple risk factors for CVD, pharmacological treatment should be considered according to published guidelines.[204]

(For further guidance on pharmacological treatment, please refer to chapter 18 Microvascular and macrovascular complications in children and adolescents and Chapter 3 Type 2 diabetes in children and adolescents)

15.2 | Celiac disease

Celiac disease (CD) is more common in children with T1D than in the general population.[205] (see Chapter 19 Other complication and associated conditions in children and adolescent).

A gluten-free diet (GFD) is the only available treatment for CD. The GFD requires elimination of wheat, rye, barley, triticale, possibly oats and products derived from these grains, brewer's yeast, malt, and food products with artificially added gluten or cross-contaminated with gluten.[206] Alternatives such as rice, preferably brown/unpolished rice, and millets, quinoa, legumes/pulses, buckwheat, amaranth, potato, corn, soy, tapioca, maize, water chestnut, and products derived from these must be used as substitutes.[207]

Recommendations to exclude oats vary between countries. Short- and long-term studies involving children and adults suggest that oats can be safely included for most people; however, a small minority of people with CD have been found to react to oats.[208] Research supports the view that gluten-free oats (oats not contaminated with gluten) may be acceptable in moderate amounts (20–25 g/day dry rolled oats for children: 50–70 g/day for adults) for the majority but not all children with celiac disease.[207–209]

The definitions of a GFD vary across the world; in Europe, Canada and USA foods containing less than 20 parts per million (ppm) (20 mg/kg) gluten are considered suitable for a GFD (even if gluten is detectable) in accordance with Codex Alimentarius.[210] Wheat starch is used in some European countries as part of a GFD, whereas it is not recommended for inclusion in Australia and New Zealand, where the legal definition states that foods must not contain any detectable gluten (less than three parts per million) if labeled as gluten-free.[211] There are no published studies to determine if there are differences in short- and long-term outcomes with the more stringent levels of gluten restriction.

GFD has been shown to result in more glycemic excursions in both adults without T1D or CD,[212] and in those with T1D and CD.[213] In a study of adults with T1D and CD, the use of fiber enriched buckwheat pasta produced less glycemic variability than corn pasta.[214] Strategies such as lower GI, higher fiber food choices, and ensuring early pre-prandial insulin administration may assist with reducing glycemic variability.

Emphasis should be placed on the nutritional quality of the GFD, particularly iron, folate, magnesium, zinc, calcium, iodine, fiber, and B vitamin intakes.[215] Nutritional deficiencies arising from a GFD can be avoided by including naturally occurring local GF whole grains, fruits, vegetables, plant and animal sources of protein, dairy, fats and oils, gluten-free commercial products that have been fortified or enriched and avoiding processed, high fat and sugar packaged foods. This will help lower the GI of the meals which are significantly altered when on a GFD.[215]

Probiotics may improve gastrointestinal symptoms in individuals with CD,[216] although more evidence is required to prove the efficacy of their therapeutic use and clinical impact in CD.

It is common for people with diabetes who develop CD to have challenges with maintaining GFD. A better understanding of the diet as well as access to a dietician and regular follow up may improve nutrition management.[217] Dietician-led follow-up visits have shown to provide lower long-term costs.[218] Factors reported to assist with GFD maintenance include adopting the GFD within the first year of diagnosis, younger age, and having family meals.[219] Young people with maladaptive eating behaviors, which are similar to risk factors for EDs, will require ongoing follow-up with gastroenterologists and dietitians plus psychosocial support to improve quality of life.[220]

BOX 6 Medical nutrition therapy for dyslipidemia in diabetes

- Reduce saturated fat intake to less than 7% and eliminate trans fats.
- Total dietary fat: 25%–35% of energy
- Diet rich in fruits and vegetables (>5 servings a day)
- Increase dietary sources of both soluble fiber and antioxidants
- Eliminate sugar-sweetened beverages and juices
- Reduce highly processed food products
- Savpid smoking

Providing educational materials (list of gluten-free foods, nutrition label reading, recipes, eating out and travel guidelines) and access to support groups, social workers, or family counseling will help improve healthy eating and maintaining GFD.[215]

15.3 | Disordered eating behavior and eating disorders

ED and DEB are more common in young people with diabetes than their peers.[221] DEB is a term used to describe a variety of disturbed eating behaviors whereas an ED is a clinical diagnosis. DEB include intentional over- and underdosing of insulin, dietary restriction, and self-induced vomiting.[31,222] Diabetes is unique in making it possible to manage weight and body shape without overt avoidance of food by means of insulin restriction. Insulin omission for reducing weight has been reported in pre-teens, adolescents and young adults and is more common in girls and young women.[223]

Diabulimia is a term that casually refers to the purging of calories through insulin restriction with the aim to lose weight or alter body shape. Diabulimia is not a clinical diagnosis and lacks a clear definition, which may lead to inaccurate descriptions of DEB and subsequently inadequate treatment. More work is needed to determine the optimal treatment strategy of young people with either diagnosed eating disorders or poorly defined disorders (see ISPAD 2022 Consensus Guidelines Chapter 15 on Psychological care of children and adolescents with T1D).

Detecting eating problems can be difficult as attention to diet and benefits of avoiding certain foods is fundamental parts of usual diabetes care. A range of screening questionnaires and structured clinical interviews are available to help identify ED and DEB in children and young people with T1D.[224,225] The Diabetes Eating Problem Survey-Revised (DEPS-R) is a 16-item diabetes-specific self-report screening tool for disordered eating that can be completed in <10 min during a routine clinical appointment.[224] The DEPS-R has been validated in several languages and can be used as a screening tool at clinic visits.[224,226,227] A recent study from Australia showed insignificant utilization of screening tools in pediatric clinics and low reported rates of ED, emphasizing the importance of both using existing tools as well as the need for user-friendly screening tools.[228] The majority of questionnaires are in English, creation of screening tools in more languages is required for non-English speaking countries. One article has found a single screening question; "Have you ever been overweight?" to have high precision in at risk individuals for further screening and early interventions.[229] Acknowledging risk factors and being attentive to signs and symptoms of DEBs can prevent progression to clinical eating disorders and further deterioration of glycemic management. See Box 7.[31]

The risk for ED increases with diabetes duration and age.[230] This is of clinical importance as adolescents transition into adulthood and require continuity of care, often across two diabetes teams. Extra attention should be paid to girls as they are more prone to DEB and are more likely to meet criteria for overweight/obesity as well as have less favorable metabolic outcomes, all risk factors for ED.[31,223,229]

BOX 7 Risk factors and indicators of disordered eating behaviors in people with diabetes

Risk factors	Warning signs suspicion for early detection	Confirmation screening tools
• 7–18 years • Female • Detailed meal planning, precision in food proportion • Overweight, obesity • Body dissatisfaction • Anxious, poor quality of life • Poor attention in family to healthy eating, maternal overweight or binge-eating disorders in mothers	• Suboptimal glycemic management • Recurrence of hypoglycemic events • Systematic calculations of caloric values and weighing of foods • Frequently missed medical check-ups • Refusal to be weighed • Concern for appearance • Tendency toward vegetarianism	• Revised Diabetes Eating Problem Survey (DEPS-R) • Modified SCOFF (mSCOFF) test • Single question "Have you ever been overweight?"

Disordered eating in young people with diabetes is associated with short-term and long-term complications such as DKA, abnormal lipid profiles, retinopathy, and neuropathy.[230]

Clinicians working with young people with diabetes and ED need to consider the following in planning interventions: insulin regimen and potential for omission, glycemic targets, energy requirements, potential for food and insulin manipulation, body dissatisfaction, family functioning, exercise type and frequency, binge eating behaviors, potential laxative abuse and sleeping patterns.

An interdisciplinary approach to treatment is considered the standard of care for both ED and diabetes. Close liaison with the Specialist Eating Disorder team is required[231] with a clear common weight goal for the person with diabetes. It is important that insulin adjustments by the diabetes team do not support binge eating or food avoidance behaviors. Supervision of insulin doses and family-based interventions are helpful strategies in treatment of disordered eating.[31] More research is needed for interventions to prevent and treat disordered eating in diabetes.

16 | RESEARCH

There is a need for further research in many areas of pediatric diabetes management and education, particularly in effective nutrition therapy interventions in relation to long-term outcomes, newer technologies and hybrid closed loop (HCL) systems. There remains a lack of high-quality studies in many aspects of nutritional management.

17 | CONCLUSION

The nutritional care of children and young people with diabetes is complex. Diabetes management occurs within the context of the family, a surrounding social system, peer pressure, emerging independence, and the aim of maintaining quality of life. It requires a deep understanding of the relationship between treatment regimens and changing physiological requirements, including growth, fluctuations in appetite associated with changes in growth velocity, varying nutritional requirements and physical activity. Evidence suggests that it is possible to improve diabetes outcomes through attention to nutritional management and an individualized approach to education. This requires a clear focus on dietary goals in relation to glycemic outcomes and reduction in CVD risk. The foundation of successful dietary outcomes is the development of a trusting relationship between the child/adolescent and care providers, which facilitates behavioral change during the challenges of childhood and adolescent development.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interest.

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