Management of nutrition in children and adolescents suffering with diabetes

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ABSTRACT

Nutrition therapy for children with diabetes is essential to improve measures of glycemic control and lipoprotein mediated risk for dyslipidemia. More innovative approaches to achieve lifestyle changes are required to meet current recommendations which are likely to produce greater beneficial changes.

1. INTRODUCTION

Nutritional management is one of the cornerstones of diabetes care and education. Different countries and regions have widely varying cultures and socioeconomic status that influence and dominate dietary habits. Sensitivity to individual needs, and pragmatism rather than dogmatism is most helpful for effective dietary counseling. According to consensus guidelines reflect national and international pediatric position/consensus statements (1, 2–5) and evidence derived from recommendations for adults with diabetes (6–8). Dietary recommendations for children with diabetes are based on healthy eating suitable for all children and adults (4, 7, 9) and therefore the whole family. Nutritional advice must be adapted to cultural, ethnic and family traditions and the psychosocial needs of the individual child. Likewise the choice of insulin regimen should take into account the dietary habits and lifestyle of the child.

Regularity in meal times and routines where the child and family sit down and eat together, helping to establish better eating practices and monitoring of food intake has been shown to be associated with better glycemic outcomes (9–13). Nutrition therapy, when used in combination with other components of diabetes care can improve clinical and metabolic outcomes (5, 6). 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 profiles. It is important that the whole family is involved in making appropriate changes based on healthy eating principles. The impact of diabetes on eating behavior must not be underestimated and may cause psychological disturbance. Therefore, dietary and lifestyle changes should be assisted by experienced professionals. Education should include behavior change approaches, motivational interviewing and/or counseling and should be regularly reviewed to meet the constantly changing needs and requirements 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 (14–16). Nutrition education and lifestyle counseling should be adapted to individual needs and delivered in a patient-centered manner. Education can be delivered both to the individual child and family and in small group settings (4, 5). These recommendations target healthy eating principles, optimum glycemic control, the reduction of cardiovascular risk factors, the maintenance of psychosocial well-being and family dynamics.

2. OBJECTIVES OF NUTRITIONAL MANAGEMENT

- Encourage appropriate eating behavior and healthy lifelong eating habits whilst preserving social, cultural and psychological well-being.
- Three balanced meals a day, with appropriate healthy snacks will supply all essential nutrients, maintain a healthy weight, prevent bingeing and provides a framework for regular monitoring of blood glucose levels.
- Provide sufficient and appropriate energy intake and nutrients for optimal growth, development and good health.
- Achieve and maintain an appropriate Body Mass Index and waist circumference. This includes the strong recommendation for children and young people to undertake regular physical activity.
- Achieve a balance between food intake, metabolic requirements, energy expenditure and insulin action profiles to attain optimum glycemic control.
- Prevent and treat acute complications of diabetes such as hypoglycemia, hyperglycemic crises, illness and exercise-related problems.
- Reduce the risk of micro- and macro-vascular complications.
- Maintain and preserve quality of life.
- Develop an enabling, trusting, empathic, supportive relationship to facilitate behavior change and consequent positive dietary modifications.

3. MONITORING ON ENERGY BALANCE, ENERGY INTAKE AND FOOD COMPONENTS

3.1. Energy balance

Appetite and energy intake are often high to restore preceding catabolic weight loss. Energy intake should be reduced when appropriate weight is restored (3).

- Energy intake varies greatly within subjects on a daily basis due to age, growth rate, energy expenditure and other important environmental factors such as the type and availability of food.
- Energy intake should be sufficient to achieve optimal growth and maintain an ideal body weight.
- Flexibility in the advice about the amount of food to meet varying energy needs (day by day and year by year) is necessary.
- Dietary advice/meal planning should be revised regularly to meet changes in appetite and insulin regimens and to ensure optimal growth.
- The insulin should be adapted where possible to the child’s appetite and eating pattern. Making a child eat without an appetite or with-holding food in an effort to control blood glucose should be discouraged as this may impact adversely on growth and development.
- In puberty, energy intake and nutritional demands increase substantially along with significant increases in insulin dosage.

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http://www.discovery.org.in/ijjs.htm
3.2. Energy intake recommendations
Total daily energy intake should be distributed as follows:
1. Carbohydrate 50–55 % (4, 7)
2. Fat 30–35%
   - <10% saturated fat + trans fatty acids (8)
   - <10% polysaturated fat
   - >10% monounsaturated fat (up to 20 % total energy) (8)
   - n-3 fatty acids: 0.15 g/day
3. Protein 10–15% (4)

4. FOOD COMPONENTS

4.1. Carbohydrates
- The energy distribution is based on requirements for healthy children (3, 9)
- The proportion of carbohydrate as a percentage of total energy intake in non diabetic children varies around the world (17)
- Encourage healthy sources of carbohydrate foods such as wholegrain breads and cereals, legumes (peas, beans, lentils), fruit, vegetables and low fat dairy products
- Sucrose does not increase glycemia more than isocaloric amounts of starch (18)
- Sucrose can be substituted in moderation for other carbohydrate sources without causing hyperglycemia (1)
- Sucrose may be used instead of glucose to prevent or treat hypoglycemia
- Sucrose sweetened drinks may cause hyperglycemia and should be avoided, if not being used to treat hypoglycemia
- Sucrose sweetened beverage consumption has been linked to excessive weight gain (19)

4.2. Fiber
For children above 1 year an amount of 2.8–3.4 gms per megajoule (20). If the energy-requirement is 5 megajoule per day (1190 kcal) the recommendation is ≈15 grams of fiber per day.
- Estimates of dietary fiber intake in children in different countries are lower than recommended (21)
- The new recommendation (2.6–3.4 grams of fiber per megajoule) tends to give a higher amount of fiber per day
- Intake of a variety of fiber containing foods such as legumes, fruit, vegetables and wholegrain cereals should be encouraged. Soluble fiber in vegetables, legumes and fruit may be particularly useful in helping to reduce lipid levels (22)
- Fruit pectin may also be useful in enhancing the protection against cardiovascular disease (23)
- Insoluble fiber found in grains and cereals promotes healthy bowel function
- Fiber should be increased slowly in the diet to prevent abdominal discomfort
- Higher fiber foods may help to improve satiety and replace more energy dense foods
- Processed foods tend to be lower in fiber therefore unprocessed, fresh foods should be encouraged

4.3. Fats
Researchers showed that children and young people with diabetes consume fat and saturated fat above dietary recommendations (24). The primary goal regarding dietary fat is to decrease the intake of total fat, saturated fat, and trans fatty acids (6). Monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) can be used as substitutes to keep lipid intake within recommended ranges or to improve the lipid profile (6).

4.3.1. Saturated fat and trans fatty acids
- Less than 10% energy from saturated fat and trans fatty acids is recommended (6). Saturated fat is the principal dietary determinant of plasma LDL cholesterol (6). 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) (6), are found in margarines, deep-frying fat, cooking fat and manufactured products such as cookies and cakes
- Replace saturated fat with MUFA & PUFA by using lean meats, fish, low fat dairy products, low fat products and changing to MUFA and PUFA cooking oils and margarines

4.3.2. Monounsaturated fatty acids and polyunsaturated fatty acid
- Unsaturated fatty acids are important components of lipid membranes
- 10%–20% energy from MUFA is recommended (5). MUFA (particularly cis-configuration) found in olive, sesame and rapeseed oils, and also in nuts and peanut butter may be beneficial in controlling lipid levels and convey some protection against cardiovascular disease. They are recommended replacements for saturated fats
- Less than 10% energy from PUFA is recommended (8). PUFA derived from vegetable origins such as corn, sunflower, safflower, and soybean or from oil
- Marine fish may assist in the reduction of lipid levels when substituted for saturated fat
- Advice for children is to eat oily fish once or twice weekly in amounts of 80–120 grams (25–27)
- 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 may be considered for children 5 years and older if total and/or LDL cholesterol remains elevated (28, 29)

4.4. Protein
- Intake decreases during childhood from approximately 2 g/kg/day in early infancy to 1 g/kg/day for a ten year old and to 0.8–0.9 g/kg/day in later adolescence (30)
- Worldwide intake of protein varies greatly depending on economy and availability
- Protein is an essential source of nitrogen
REVIEW

- Protein promotes growth only when sufficient total energy is available
- Sources of vegetable protein such as legumes should be encouraged. Sources of animal protein also recommended include fish, lean cuts of meat and low fat dairy products (3)

4.5. Vitamins, minerals and antioxidants

- Children with diabetes have the same vitamin and mineral requirements as other healthy children (9)
- Optimum vitamin, mineral and antioxidant intake should be maintained for general health and cardiovascular protection
- Many fresh fruits and vegetables are naturally rich in antioxidants (tocopherols, carotenoids, vitamin C, flavonoids) and are strongly recommended for young people with diabetes
- Supplements such as vitamin D for young children are recommended in some countries.

4.6. Salt

- Less than 6 g/day should be taken.
- Salt intake is too high in many countries due to the high intake of processed foods
- Processed foods should be decreased for the whole family and practical advice given to develop cooking skills with fresh foods
- Reduction is recommended to that of the general population (8)
- Dietary advice should include no added salt to cooking or meals

4.7. Alcohol

Excess alcohol is dangerous because of suppression of gluconeogenesis and may induce prolonged hypoglycemia in young people with diabetes (up to 10–12 or more hours after drinking, depending on the amount ingested) (31). Education should be emphasized when a child starts to include alcohol in their lifestyle.

- Alcohol in children may lead to increased risk taking behaviors
- Carbohydrate should be eaten before and/or during and/or after alcohol intake. It may be also necessary to adjust the insulin dose particularly if exercise is performed during/after drinking
- Special care should be taken to prevent nocturnal hypoglycemia by having a carbohydrate snack at bedtime and monitoring blood glucose (BG) levels more often than usual during the night and the following day, at least until lunchtime (4)

4.8. Artificial and intense sweeteners

- Water should be encouraged instead of sugary drinks and cordials
- Sugary or diet fizzy drinks are not encouraged for the general population.
- Products such as low fat yoghurt with intense sweeteners can be useful, especially for those who are overweight
- Saccharin, aspartame, acesulfame K, cyclamates, alitame and sucralose are used in low sugar, "light" or "diet products to improve sweetness and palatability

5. RECOMMENDATIONS FOR NUTRITIONAL CARE, EDUCATION AND MEAL PLANNING

1. Initial dietary advice should be provided as soon as possible after diagnosis to promote a secure, trusting and supportive relationship (16). A dietary history should be taken including:
   a. Pre-existing family dietary habits, traditions and beliefs
   b. The child’s usual food intake including energy, carbohydrate distribution and fat intake, quality of food choices, fast foods and mealtimes or patterns of food intake
      i. The child’s daily activities including the impact of nursery/school/college/work, physical activity and exercise schedules
2. Simple advice should be given at the first meeting but reviewed by the specialist pediatric dietician within at least a month after diagnosis (7).
3. Contacts thereafter depend on local arrangements, a minimum should include 2–4 times in the first year and annual reassessment. These are necessary to keep pace with the child’s growth, diabetes management, psychosocial adaptation, lifestyle changes and the identification of specific dietary problems such as dysfunctional eating habits, family issues around food, obesity and Eating Disorders.
4. Circumstances such as changing insulin regimen, dyslipidemia, poor dietary knowledge, excessive weight gain, and co-morbidities such as celiac disease require extra education and dietary intervention with more frequent review.

5. Dietary education should be individualized and appropriate for the age and maturity of the child to help engage the child in active learning (32–34).

6. EDUCATION TOOLS AND METHODS

- Education tools and methods are used to provide knowledge and skills to optimize glycemic control and cardiovascular outcomes.
- The methods used should be varied, appropriate to the child, adapted to the needs of the family and staged at a pace with which the family is comfortable
- Blood glucose monitoring (pre and post-prandial) provides essential information to confirm the success of the chosen method.
- As families become more confident with managing diabetes, education should be responsive to developmental changes and lifestyle
- As children grow and take more responsibility, regular re-education is essential
- Further examples of teaching tools can be found on the International Diabetes Federation web-site (35). It is essential that dietary education tools are selected carefully for each child and family to achieve maximum understanding and adherence.

6.1. Healthy eating education tools

Food pyramids (Fig. 1) and plate models (Fig. 2) are useful in providing basic nutritional information and healthy eating concepts. They also illustrate visually carbohydrate containing...
foods in relation to other food components and are attractive visual aids for children. Regular meals and snacks (at least three balanced meals per day) ensure that the ranges of nutrients are consumed to meet daily recommended requirements (9).

6.2. Carbohydrate assessment and methods
- It is a serious over-simplification to suggest that glycemic control is only affected by the amount and type of carbohydrate.
- Other variables such as endogenous and exogenous insulin levels, exercise, composition of the meal/snack (protein, fat, fiber), type of starch, cooking method
- of carbohydrate, gastric emptying and hormonal function are a number of variables that are difficult to measure and quantify
- Research has not demonstrated that one method of assessing the relationship between carbohydrate intake (grams/portions/exchanges), type (glycemic index and glycemic load) and blood glucose response is better than other methods (2).

However, most education tools are based upon the premise that carbohydrate amount and type is recognized as the primary determinant of the postprandial response (36) and along with distribution of carbohydrate (37) form the basis of most education programmes. Education regarding carbohydrate intake must be individualized to the child and family according to their circumstances, understanding, ability, motivation, personal choice and the insulin regimen. Practical guidance on the distribution of carbohydrate intake, as part of management, is necessary for both fixed and more flexible insulin regimes (1–3, 5). Methods of quantifying carbohydrate in common use include:

A. Carbohydrate counting
Modern carbohydrate counting is a meal planning approach that focuses on improving glycemic control and allowing maximum exibility of food choices. Three levels of carbohydrate counting have been identified by the American Dietetic Association (38,39).

Level 1: Carbohydrate counting. This level introduces the basic concept of carbohydrate as the food component that raises blood glucose. A consistent intake of carbohydrate is encouraged using exchange or portion lists of measured quantities of food.

Level 2: Pattern management principles. This level is an intermediate step in which patients continue to eat regular carbohydrate, use a consistent baseline insulin dose and frequently monitor BG levels. They learn to recognise patterns of response to carbohydrate (and other food) intake modified by insulin and exercise. With this understanding and team support they learn to make adjustments to their insulin dose or alter carbohydrate intake or timing of exercise to achieve blood glucose goals.

Level 3: Insulin to carbohydrate ratios. This level of carbohydrate counting is appropriate for people on Multiple Daily Injections (MDI) or insulin pump therapy. It involves the calculation of insulin to carbohydrate ratios that are individualized for each child according to age, sex, pubertal status, duration of diagnosis, time of day and activity. With the determined insulin:carbohydrate ratios, adjustment of pre-meal insulin according to the estimated carbohydrate content of the meal or snack is enabled. This has been shown to improve dietary freedom and quality of life in adults with T1DM (40). It is at present being evaluated in young people (33, 34), the results being variable showing no or some improvement in glycemic control respectively.

B. Exchange or portion system
This system teaches that it is not necessary to count precise grams. Exchanges/portions are taught as either 10 or 15 gram servings of carbohydrate. The exchange or portion system can be used to recommend carbohydrate amounts for each meal and snack to enable a more consistent daily intake of carbohydrate. Alternatively, exchanges or portions can be used in intensive insulin therapy to enable matching of insulin dose to carbohydrate intake.

C. Glycemic index and glycemic load
The use of the glycemic index (GI) has been shown to provide additional benefit to glycemic control over that observed when total carbohydrate is considered alone (41). A controlled study in children using the GI of foods found flexible dietary instruction based on the food pyramid and low-GI choices achieved significantly better glycemic control after 12 months than more traditional dietary advice (42).
- Low GI carbohydrate foods (GI<55) may lower post-prandial hyperglycemia when they are chosen to replace higher GI foods (GI>70) (41).
- Examples of low GI food sources include wholegrain breads, pasta, temperate fruits and dairy products (43). Glycemic load (GL) is another method for predicting the postprandial blood glucose response, which takes into account both the GI of the food and the portion size (44).

6.3. Nutritional management of exercise and sport
Children and adolescents with diabetes should be encouraged to participate in regular physical activity because it promotes cardiovascular health and aids weight management (45). However, planned or unplanned physical activity is one of the commonest causes of hypoglycemia in young people with type 1 diabetes, and intense physical activity sometimes causes hyperglycemia (70). Nutritional management of physical activity aims to prevent the potential hypoglycemic and hyperglycemic effects. Advice is also necessary to meet the nutritional requirements for sports performance in those individuals wishing to train and compete. Advice on physical activity, exercise and sport should emphasise the importance of careful planning, individual attention to detail (blood glucose monitoring, food intake and insulin management) and incorporating the personal experiences of both the young person and health professional. Exercise should be delayed if control is poor (blood glucose >15 mmol/l or if ketones are present) until the diabetes is under better control with insulin administration (6, 46–48). Unplanned & spontaneous activity Hypoglycemia is the commonest problem associated with unplanned physical activity. Depending on the duration and intensity of exercise, this may occur during or after exercise, in the period of increased insulin sensitivity and muscle recovery.

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 (49). Carbohydrate in a readily digestible form should be available for consumption immediately or within one hour of completing exercise. Where post exercise hypoglycemia occurs, the amount of carbohydrate required to correct this may be greater than for a non exercise induced hypoglycemic event, due to the depletion of liver and muscle glycogen stores (49).

6.4. Nutritional management of type 2 diabetes in children and young people
In young people with type 2 diabetes and insulin resistance, the presence of multiple cardiovascular risk factors is likely to be...
6.5. Treatment recommendations

There is little evidence regarding the nutritional treatment of type 2 diabetes in children. Therefore recommendations are derived from the treatment of overweight and obese children, type 2 diabetes in adults and type 1 diabetes in children:

- Most children with Type 2 diabetes are overweight or obese, therefore treatment should be centered on education and lifestyle interventions to prevent further weight gain or achieve weight loss with 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 most often overweight or obese and have diabetes as well. Studies indicate that a family approach to treatment of overweight is most likely to be effective (53). Interventions have shown improved outcomes from using parents as positive role models in healthy food choices and changing behaviors to increase physical activity
- 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 high sugar and high energy beverages such as soft drinks and juices can accomplish improvement in blood sugars and weight (19)
- Increasing energy expenditure by increasing daily physical activity is an important component of treatment (3, 52). Decreasing sedentary behaviors, such as television viewing and computer use has been shown to be an effective way to increase daily physical activity and help to maintain or achieve healthy weight in children (54, 55). Physical activity may also help lower lipids in adolescents with diabetes (56)
- It would be sensible to consider the meal-by-meal and day-to-day consistency in carbohydrate intake to aim for stable blood sugar levels
- Those on medication or insulin therapy require more in depth teaching on carbohydrate management
- Submission of low GI foods for high GI foods may assist with control of appetite, weight and lipid levels in adolescents with Type 2 Diabetes (57, 58)
- Regular follow-up is essential to monitor weight, glycemic control and medication

6.6. Eating disorders and diabetes

A range of screening questionnaires and structured clinical interviews are available to help identify and diagnose eating disorders in children and young people (59, 60). Diabetes is unique in making it possible for weight and shape control without overt avoidance of food. Insulin omission for weight control has been reported in 12–15% of adolescents and it is increasingly recognized that adolescents may manipulate their insulin dose and/or diet because of weight concerns, in ways that are similar to those of an Eating Disorder (61). It is thus recognized that poor glycemic control may reflect insulin omission in association with disordered eating. This may be driven by weight concerns as well as additional emotional disorders (60). Eating disorders (ED) in adolescents and young adults with diabetes (DM) are associated with poor metabolic control and diabetic complications (61–63). This association is even more of a concern in young people with an increased risk of early onset of diabetic complications and evidence of ineffectiveness of treatment for the eating disorder (64). Classical approaches to eating disorder diagnosis and management need to be modified to incorporate the specific demands of diabetes regimens.

6.7. Behavioral approaches in diabetes dietary education

Adolescence represents a critical stage in the development of self-management of food intake and diabetes, accompanied by independent decisions about health and lifestyle choices. It is known that psychological issues such as behavior disorders and depression are greater in children with diabetes, and this in turn is associated with poor metabolic control (65, 66). Risk taking behaviors, eating disorders and non-adherence to diabetes regimens are common (67). The traditional medical model, based on health professionals assuming responsibility for their patient’s health, often leads to frustration both for diabetologists and adolescents with diabetes (16). There are few recognized and standardized interventions that specifically target children with diabetes (68). However, systematic reviews have shown that psychoeducational interventions provide an alternative model of patient care and have small to medium beneficial effects on glycemic and behavioral outcomes (69–71). Family communication is also important and structured education programs which support open communication about diabetes and regular renegotiation of roles and shared family responsibilities throughout adolescence may be more effective than skills training alone (72). Exploring problem-solving skills through experiential learning has been shown to lead to greater self-efficacy and improved dietary outcomes (73).

- Pediatric dieticians should be aware of research results and be trained in family communication skills, counseling, psychology, behavior modification approaches and motivational interviewing
- Training in behavioral and psychological skills would enable earlier identification of those children and families who may be struggling with diabetes or with weight control and allow earlier referrals to specialist care such as, psychologists, eating disorder teams and child and family therapists.

7. SUMMARY

The nutritional care of children with diabetes is complex. Diabetes management is set within the context of the family, a surrounding social system, and multiple carers, often deteriorating national dietary characteristics, issues of non-compliance, peer pressure, emerging independence and the ultimate aim of maintaining quality of life. It requires a deep understanding of the relationship between treatment regimens and constantly changing physiological requirements, including growth, fluctuations in appetite associated with changes in growth velocity, varying nutritional requirements and sporadic episodes of physical activity. Nevertheless, evidence suggests that it is possible to improve diabetes outcomes through meticulous attention to nutritional management and an individualized approach to education. This requires a clear focus on dietary goals in relation to glycemic control and the reduction in cardiovascular risk. The fundamental premise of successful dietary outcomes is the development of a trusting relationship between the health professional, child and carers, which facilitates behavior change during the challenges and turbulence of childhood and adolescent development.

8. RECOMMENDATIONS

- Dietary recommendations are based on healthy eating principles suitable for all children and families with the aim of improving diabetes outcomes and reducing cardiovascular risks
- Nutritional advice should be adapted to cultural, ethnic and family traditions, as well as the cognitive and psychosocial needs of the individual child
- Specialist pediatric dieticians with experience in childhood diabetes should be part of the interdisciplinary team and should be available as soon as possible at diagnosis to develop a lasting trusting relationship
- Energy intake and essential nutrients should aim to maintain ideal body weight, optimal growth, health and development and help to prevent acute and chronic complications. Growth monitoring is an essential part of diabetes management
- Total daily energy intake (TDEI) should be distributed so that carbohydrate forms >50%, Fat <35% (saturated fat <10%), and Protein 10–15% of TDEI. Sucrose can provide up 10% of TDEI
- There is no strong research evidence to demonstrate that one particular educational tool or method of quantifying carbohydrate intake (grams/portions/exchanges/glycemic index or load) is superior to another
- Strategies to increase physical activity and incorporate meal planning with appropriate insulin adjustments can improve glycemic control
- Conventional insulin regimens demand some consistency in carbohydrate intake to be successful
- Intensive insulin regimens allow greater flexibility so long as the matching of insulin doses to carbohydrate intake is understood and applied.
- However, regularity in meal times and eating routines are still important for optimal glycemic outcomes.
REFERENCES


35. IDF Diabetes Education modules - view or order free booklet and CD-ROM with teaching slides www.idf.org.


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