5

The Nutritional Management of Children's Diabetes

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INTRODUCTION

There is considerable consensus on the nutritional management of children and adolescents with diabetes, which has been brought together in the ISPAD Consensus Guidelines 2000 (1), having initially evolved from adult nutritional recommendations (2,3). Effective nutritional management for children and adolescents with diabetes is important not only for glycaemic control but also for long-term cardiovascular risk prevention in a group particularly susceptible to future heart disease (4,5).

To achieve these nutritional objectives paediatrically trained dietitians with experience in diabetes are essential (1,6). The assessment and management of the nutritional needs of diabetic children is both skilled and complex, requiring an understanding of childhood and adolescent psychology and family dynamics alongside a detailed knowledge of diabetes care. Simply transferring knowledge is not enough as effective management requires motivating behavioural changes, which is more difficult in the young than other age groups, especially in adolescence, when adherence to all aspects of their diabetic care is poor (7). This makes negotiation and compromise essential tools.

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The safety and quality of life of children and adolescents with diabetes must not be compromised while trying to achieve the nutritional objectives outlined above. Consideration therefore needs to be given to an individual's:

- age
- lifestyle
- culture and beliefs
- food preference
- eating patterns
- food availability
- financial circumstances

An understanding and appreciation of the family's dietary habits is paramount before nutritional advice and education can begin. Ideally a home visit around the time of diagnosis by the dietitian should be made as this provides an insight into the family way of life and highlights potential constraints upon future dietary compliance. Not only will foods vary within households but also the timing of meals and styles of eating. Special attention needs to be given to the level of psychological and social development of the child and any dietary advice given should be set in the context of the whole family as this helps to prevent psychosocial isolation and makes meal planning within the family easier. Peer pressure must be acknowledged and discussed as it can contribute to major nutritional changes, especially in adolescence.

Today it is necessary for the paediatric dietitian to be able to provide nutritional advice for an increasing variety of different types of diabetes. Up until recently childhood diabetes was almost exclusively Type 1 in origin, this however is changing as the incidence of Type 2 diabetes in adolescents is increasing and predicted to continue to increase with the rapid rise in childhood obesity (8–13). Diabetes secondary to chronic childhood disorders such as cystic fibrosis and haemoglobinopathies is also increasing, as more of these children live on into young adulthood (14,15). Other forms of diabetes due to specific monogenetic gene defects of insulin secretion (MODY) are being increasingly diagnosed (16).

There are numerous challenges ahead for the paediatric dietitian treating diabetes. Despite overwhelming evidence that tight metabolic control matters and can reduce the development of microvascular complications (17), the changes in the environment in which we strive to achieve this level of diabetic control are increasingly hostile to good lifestyle behaviour. The disestablishment of the family unit and with it set family meals has helped fuel the deteriorating diets and rise in consumption of fast foods, and these eating patterns have been confounded by the rise in levels of physical inactivity in young people.

MAIN NUTRITIONAL RECOMMENDATIONS

These are similar to nutritional recommendations for adults with diabetes (2,3). Children above 5 years should be encouraged to adopt these adult nutritional recommendations, while children under 5 years require a more energy-dense diet, see Table 5.1.

Table 5.1 Nutritional recommendations for childhood and adolescent Type 1 diabetes

1. Healthy eating principles applicable to the whole family

2. Distribution of energy and carbohydrate intake to balance insulin action profiles and exercise (and adjustment of insulin doses to varying food patterns)

3. Total energy needs to be sufficient for growth but to avoid overweight and obesity

4. Total daily energy intake should be distributed as follows:

   (i) Carbohydrate > 50%
   mainly as complex unrefined higher fibre carbohydrate
   promote soluble fibre
   moderate sucrose intake
   (ii) Fat 30–35%
   < 10% saturated fat
   < 10% polyunsaturated fat
   > 10% monounsaturated fat
   (iii) Protein 10–15% (decreasing with age)

5. Fruit and vegetables (recommend five portions per day)

AIMS OF NUTRITIONAL MANAGEMENT OF CHILDHOOD AND ADOLESCENT TYPE 1 DIABETES

- Provide appropriate energy and nutrients for optimal growth, development and health
- Achieve and maintain ideal body weight
- Achieve and maintain optimal glycaemic control on an individual basis, balancing food intake with metabolic requirements, physical activity and insulin treatment
- Prevent hypo- and/or hyperglycaemia due to insulin, illness and exercise
- Reduce the risk of long-term micro- and macrovascular complications
- Preserve social and psychological well-being

'PROVIDE APPROPRIATE ENERGY AND NUTRIENTS FOR OPTIMAL GROWTH, DEVELOPMENT AND HEALTH'

Energy and Nutrients

Children with well-controlled diabetes have similar average energy intakes and nutrient requirements as their peers. As individual daily intakes and requirements vary due to growth, maturity and exercise, nutritional requirements need to be reviewed regularly with the use of height/weight growth charts. All advice should aim to achieve ideal body weight while meeting the recommendations specified in the Dietary Reference Values (DRVs) for the United Kingdom (18).

Growth in Relation to Energy Balance and Metabolic Control

Children's growth rate is continually changing but the phases of particularly rapid growth are in infancy and puberty. Health care professionals need to be made aware that for optimal growth between 6 and 12 years children with diabetes must double their energy intake. Total energy and protein intake needs to increase at this time. However after these rapid phases of growth, or cessation of growth, failure to reduce energy intake will lead to obesity. Adjusting dietary intake during these continually changing metabolic demands is central to the dietary management of childhood diabetes and requires ongoing regular review by a trained paediatric dietitian.

Growth potential may not be fulfilled when glycaemic control is poor, as glycosuria can cause significant urinary energy loss while insufficient insulin treatment can cause inadequate anabolism. Energy requirements, carbohydrate intake and insulin doses increase throughout childhood and rise markedly during puberty. Adolescents and parents need to be reassured that increasing carbohydrate intake is both normal and essential at this time and will not jeopardise overall metabolic control. Parents often compensate for the increased appetite of puberty by increasing inappropriate non-carbohydrate foods that are high in fat and/or protein. In boys, particularly, appetite can increase dramatically during the pubertal growth spurt and parents and adolescents need to appreciate that any increase in food intake should be accompanied by an increase in insulin dose.

Protein

The normal protein requirements are:

- 2 g/kg per day in early infancy
- 1 g/kg per day for a 10-year-old
- 0.8 g/kg in later adolescence towards adulthood

Children in Western countries however find it easy to exceed these requirements, obtaining 15–20% of their total energy intake as protein (19), while a safer level is nearer 10–15% (1,19,20).

Proteinuria (albumin excretion rate $>300\,\mu g/min$) is uncommon before puberty but microalbuminuria may start or accelerate during puberty. Sustained high protein loads may be detrimental to renal function, especially if there is renal disease (19,21), and this is particularly important in adolescents. However, any protein restriction should not be allowed to compromise normal growth and maturation and it is essential under these circumstances that careful nutritional and metabolic assessment is carried out.

Animal sources of protein are associated with higher fat intakes, especially saturated fat and therefore should not be consumed in large amounts. Vegetable protein is lower in fat, higher in fibre and complex carbohydrates and should therefore be encouraged. Until further evidence is available it is not necessary to decrease protein intake below that recommended for non-diabetic children and in the UK the national standard DRVs for Food Energy and Nutrients for the United Kingdom should be adhered to (18).

Carbohydrate

Children in the UK achieve 51% of total energy intake from carbohydrate (22); however, children with diabetes find it more difficult to achieve the recommended targets and have a lower reported carbohydrate intake of 49% (23). More practical suggestions may be useful to encourage larger amounts of carbohydrate to prevent excess protein and fat intakes.

Sucrose

Work in adults with diabetes has shown that sucrose has a lower glycaemic index than most starches (24,25). Studies in children have shown no correlation between glycaemic control and 'total' sucrose intake; however, if sucrose is eaten in isolation and excess this will affect control (26,27). These findings support a more liberal approach to sucrose intake when part of mixed meals or mixed with foods with a low glycaemic index, and this more flexible approach to sucrose can make food more palatable to children. It is reasonable to follow the recommendations for sucrose for the general population, that for many countries is less than 10% of total energy. In addition to glucose, sucrose can be used before exercise and for the treatment of hypoglycaemia. A reduction in sucrose must however also be considered in overweight children.

Dietary Fats

Dietary fat intake and the fatty acid composition are important in diabetes because of the associations with cardiovascular disease. The dietary

recommendations for fat and fatty acids have been formulated for adults (18) but not separately for children. Therefore the intake of children above 5 years should follow the DRVs for adults. Up to the age of 5 years it is expected that the proportion of energy derived from dietary fats will fall from about 50%, as supplied by breast feeding or infant formula, to those recommended for adults. This change should not occur before 2 years old. In practice this means that the change from whole fat milk to semi-skimmed or even skimmed milk should be delayed until the age of 2. Below this age a high energy density of foods is important, and in addition if low-fat foods are given to toddlers there can be associated rapid gastric emptying and diarrhoea.

Saturated Fatty Acids

A diet low in saturated fat can lower total and low-density lipoprotein (LDL) cholesterol (28), which are strong predictors of coronary heart disease. In European adults with Type 1 diabetes, the saturated fatty acid intake represents 14–17% of total energy (29). In children without diabetes it is 14 (22) and although at the lower end of the adult range, it is above the 10–11% of dietary energy recommended (1,2,3,18). These figures support the view that children as well as adults require greater practical advice on reducing saturated fat intake.

Polyunsaturated Fatty Acids (PUFAs)

The DRV for PUFAs is 6.5% (18); WHO recommendations for the general population are 3–7% (18) and the ISPAD Consensus Guidelines 2000 (1) for children with diabetes are $< 10\%$ of total energy.

Cis polyunsaturated fatty acids can be divided into two main groups, *cis n*-3 and *cis n*-6. These groups have different beneficial biological functions and are found in different foods. Fish oils are the richest source of *cis n*-3, with seed oils and margarines also providing alternative sources. *Cis n*-6 polyunsaturated fatty acids are found mainly in plant oils, including soya, corn and sunflower oils, and margarines manufactured from these oils.

In the UK childhood population the average total intake of energy from *cis* polyunsaturated fatty acid is 6% (22). For infants, children and adults the DRV recommendations (18) are that linoleic acid (*cis n*-6) should provide at least 1% of total energy and α-linolenic acid (*cis n*-3) at least 0.2% of total energy. A report on nutritional aspects of cardiovascular disease (30) recommended that no further increase in average intakes in respect of *cis n*-6 was required but *cis n*-3 should increase from around 0.1 g a day to 0.2 g. Data are not available for individual fatty acids intakes for the general childhood population, however intakes of total *cis n*-3 and *cis n*-6 are above the DRVs set for individual fatty acids (22), suggesting that young people meet the DRV levels. Guidance with emphasis on a good balance of both *cis n*-3 and *cis n*-6

seems appropriate, as encouraging moderate intakes of these polyunsaturated fatty acids in a mixed diet will in consequence help to reduce overall saturated fat intake. Supplementation is not recommended as evidence of any benefit is conflicting on LDL cholesterol or glycaemic control.

Cis Monounsaturated Fatty Acids (MUFAs)

Ideally most dietary energy should be derived from a combination of *cis* MUFAs (13% of total energy) and high soluble-fibre carbohydrate. High MUFA intakes have several potential metabolic advantages including improving insulin sensitivity, glycaemic control and possibly reducing atheroma (28). A major benefit of a higher MUFA diet is palatability and aiding compliance to an otherwise low-fat diet. Donaghue *et al.* (31) have shown that even a modest increase in monounsaturated fat in adolescents with Type 1 diabetes seemed to improve insulin sensitivity.

The mean MUFA intake for the childhood population without diabetes is 11.8% of total energy (22). The intakes of children with diabetes are likely to be similar, however sources of MUFA in the UK are not as readily available as in other European countries, particularly some of the Mediterranean countries. Practical advice to increase MUFA intake should include promoting olive oil or rape seed oil and other rich sources such as specific margarines with a high monounsaturated fat content.

Trans-isomer Fatty Acids

Some *trans*-isomers of PUFAs occur naturally but most are formed during partial hydrogenation of vegetable oils to produce margarines and vegetable shortening found in baked goods and pastries. The *trans*-isomers of PUFAs have similar detrimental metabolic effects as saturated fatty acids and for practical purposes should be considered the same. The present mean intake of children without diabetes is 1.4% of total energy (22).

Lower Fat Snacks

The school snack, mid-morning, is often the most difficult one of the day, as it has to be taken or bought at school, carried in the school bag, and most importantly acceptable to peer group scrutiny. In the UK this often allows for few healthy alternatives as children do not want to eat fruit in front of their friends, in other European countries this is less of a problem as children usually choose much healthier snacks (32). Nevertheless dietary education should centre on lower fat snacks that are familiar to children. The fat content of snacks such as fruit or a bag of crisps can range from 0–12 g fat per portion, respectively, with similar carbohydrate values. The lower fat products such as

corn chips, potato sticks, etc. should be encouraged and discussed with the child to help them in selection. Pictorial illustrations are often useful.

Vitamins and Antioxidant Micronutrients

Foods naturally rich in vitamins and dietary antioxidants (tocopherols, carotenoids, vitamin C and possibly flavonoids) should be strongly encouraged. Highly reactive oxygen free radicals are increasingly implicated in the pathogenesis of atherosclerosis and foods rich in antioxidants, such as fresh fruit and vegetables, may provide a means of protecting against long-term cardiovascular disease in populations at increased risk.

Unfortunately the intake of vitamins and dietary antioxidants in the UK is low among young children (22). Scientific evidence on their benefits is still evolving and further research is required in children before firm recommendations can be made. In the meantime it is appropriate to achieve at least the DRVs for vitamins and to promote foods that naturally contain significant quantities of dietary vitamins and antioxidants (33). Present evidence does not support the use of dietary supplementation with vitamins or minerals.

Non-starch Polysaccharide (Previously Known as Fibre)

Non-starch polysaccharides may be classified into two broad categories – *soluble* (including gums, gels, pectin) and *insoluble* (including cellulose and lignin). Intakes are recommended to the level suggested for the general population. However intakes may be low in European countries and meeting desired targets may involve considerable change for some children and their families (34). A reasonable first target would be 1 g/100 kcal/day (similar to non-diabetic children), rising to 2 g/100 kcal/day, with emphasis on soluble fibre (20). Soluble fibre can benefit both glycaemic control and lipid metabolism, reducing both fasting and post-prandial glucose values. An improvement in insulin sensitivity is postulated as the mechanism by which soluble fibre can improve fasting hyperglycaemia. The benefits of increasing soluble fibre are supported by studies in children (19). Fruit and vegetables are good sources of soluble fibre and emphasis should be placed on increasing intake, as most children with diabetes, like non-diabetic children in the UK, eat considerably less than the daily five portions of fruit and vegetables recommended (22).

Salt

Salt intake is in general too high and in Western countries difficult to decrease as it is added to many processed foods (only 20% of intake is added at the table and in cooking). Two-thirds of the children in the National Diet and Nutrition Survey had salt added to their cooking and salt was added to food at the table,

either usually or occasionally, by about half of the young people (22). Dietary habits are learned in childhood and difficult to change. Therefore these practices should be discouraged for the whole family and practical advice to develop cooking skills to reduce the intake of processed foods would help to reduce salt consumption. Reduction is recommended to that of the general adult population. In most European countries this constitutes a reduction of 50%, to less than 6 g of salt daily.

Alcohol

Alcohol has no place in the normal nutrition of young people with or without diabetes, and in many countries alcohol ingestion in children and young teenagers is either illegal or culturally unacceptable. However, since most UK adolescents do experience and experiment with alcoholic drinks the effect of alcohol on their diabetes requires discussion. It is important to explain the risks of alcohol-induced hypoglycaemia and stress the dangers of nocturnal hypoglycaemia induced by inhibition of gluconeogenesis. The benefits of taking complex carbohydrates before, during and after drinking alcohol to reduce the risk of hypoglycaemia need to be explained.

Nutritive Sweeteners

These include glucose, sucrose, fructose and sugar alcohols such as sorbitol. All contain energy and should be considered if weight is a problem. The sugar alcohols have a lower glycaemic response than sucrose and have a slightly lower energy value. Large quantities may cause osmotic diarrhoea and some children are particularly sensitive.

Non-nutritive Sweeteners

These include saccharin, aspartame, acesulfame K, cyclamates, alitame and sucralase and may be used in low-sugar products to improve variety and compliance. Acceptable daily intakes have been established. Fears that these sweeteners may contribute to hyperactivity in children have not been substantiated.

'ACHIEVE AND MAINTAIN IDEAL BODY WEIGHT'

The diagnosis of Type 1 diabetes in a child is usually preceded by weight loss and initially extra energy is required to re-establish optimal weight. The appetite and food intake may double in the first 2–3 weeks after diagnosis and parents need to be reassured that this is a healthy physiological reaction that will settle. This increased appetite is a good opportunity to establish a regular carbohydrate intake and introduce new healthy foods that may become

established in the future diet. This is a critical time to ensure that there is not an overshoot towards excessive weight gain.

Weight management during puberty is an important issue. Paradoxically (particularly in girls) energy requirements may actually decrease due to an unfortunate decline in the frequency and intensity of exercise, and when this occurs weight gain can become a problem. Puberty is also associated with insulin resistance and insulin doses need to increase to prevent hyperglycaemia but weight gain may accompany this increase in insulin administration. Regular monitoring of weight and height will help to identify potential weight problems in puberty, too much or too little, and allow insulin, food and weight management advice to be given promptly. Prevention of weight gain is a major priority because it is difficult to lose once gained and often the problem is transferred into adulthood. All aspects of diabetic control are compromised when the body mass index (BMI) rises; insulin sensitivity decreases, glycaemic control deteriorates and dyslipidaemias and hypertension can manifest themselves (35).

Intensive Insulin Management

Intensified insulin therapy to improve glycaemic control may have the negative effect of increasing weight, as demonstrated in the Diabetes Control and Complications Trial (17). Close nutritional supervision and weight management should accompany intensive therapy to prevent weight gain (17,36).

The intensive therapy group in the DCCT also experienced a threefold increase in hypoglycaemia (17). The need to carefully balance nutritional intake to insulin therapy was one of the important conclusions of the DCCT and stressed the importance of dietary re-education when intensified insulin management is introduced. Advice is difficult, as it needs to be directed simultaneously to reducing total energy and the fat/carbohydrate ratio, avoiding hypoglycaemia with regular carbohydrate while improving or maintaining good glycaemic control.

'ACHIEVE AND MAINTAIN OPTIMAL GLYCAEMIC CONTROL ON AN INDIVIDUAL BASIS, BALANCING FOOD INTAKE WITH METABOLIC REQUIREMENTS, PHYSICAL ACTIVITY AND INSULIN TREATMENT'

Initial Consultations

The newly diagnosed child and parent have an enormous volume of information to assimilate. This ranges from factual issues, such as what is diabetes, to technical issues, such as how to inject and adjust insulin and monitor blood sugars. In addition they are given information on what they can eat and how all these factors affect each other. This deluge of information is

often overwhelming and frightening. Additional issues that health care professionals may feel important should be considered carefully and where possible delivered later. Initial consultations should be used to develop a trusting relationship with the child and parent establishing rapport, confidence and understanding. This time should be spent on how the child feels, and is coping with the initial tasks of diabetes. The focus should be on their immediate questions and real concerns. Usually the first question parents ask is 'What can we eat?' Useful prompts at these times include:

- '*How do you feel about the diabetes?*'
- '*What are your worries about food and diabetes?*'
- '*How will your eating habits at home affect diabetes?*'
- '*Do you think you will have to change the way you and the family eat?*'

It is particularly important to establish if other family members have diabetes and the influence this already has on the family eating pattern.

The interplay of insulin with food, eating habits, the timing of meals and snacks and even a wider discussion of insulin effects on metabolism in general should take place, if appropriate to the individual's level of understanding and perception of diabetes management.

A diet history should be taken to support any changes suggested, although this need not occur at the first appointment, if the parent or child has raised a number of emotional issues and concerns that need addressing. Completion of a food diary for review at a future appointment is often a more productive use of time. All information should be provided at a level appropriate to assist the child to achieve their immediate goals while addressing any concerns. Appropriate information at this stage may be very practical advice for the next supermarket shop or how to read food labels.

Events during the early days and weeks after diagnosis undoubtedly have a lasting impact on long-term control (see Chapter 3) and there is some evidence that if glycaemic control is good in the first 5 years long-term diabetic outcomes are improved (37–39). It is essential that the dietitian is perceived at this important time as being an ally and not prescriptive or dogmatic, taking little notice of immediate fears, crucial cultural and behavioural aspects of the family and their eating pattern. The DCCT showed conclusively that dietitians need to develop skills in communication, counselling and motivational interviewing to facilitate necessary effective changes (36).

Education Methods

The DCCT also showed that meticulous attention to both diet (36,40) and insulin management (17) produced better glycaemic control and reduced complication rates. Dietary education tools need to be selected carefully for each child and family to achieve maximum understanding and compliance.

Educational tools should be varied, appropriate to the needs of the family and staged at a pace with which the family is comfortable. As families become more confident with managing diabetes, education may become more complex and as children grow and take more responsibility, regular re-education is essential. The dietitian should have developed the skills to deliver any of the following methods and in this way the needs of the individual child and family can be met. The mode of transfer of the information should also be appropriate to the child's age and developmental level.

Food pyramids, Figure 5.1, and plate models, Figure 5.2, are useful in providing basic nutritional information and healthy eating concepts. They also illustrate visually carbohydrate in relation to the other food components and should be attractive visual aids for children.

Carbohydrate Management

Many methods of counting or estimating carbohydrate intake are used in paediatric practice, for example, intensive nutritional management with

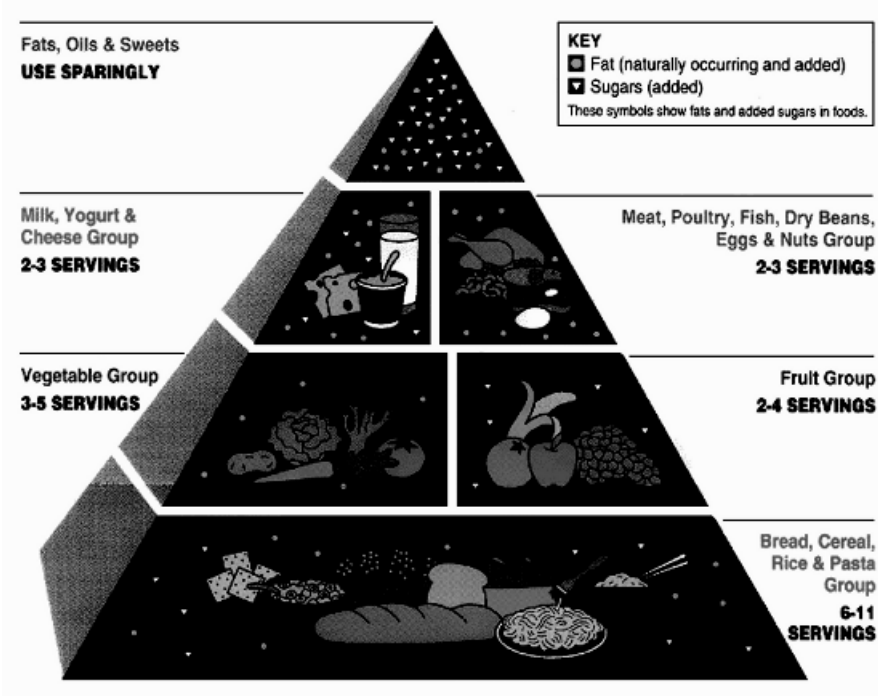

Figure 5.1 Food pyramid. Reproduced from US Department of Agriculture: Food and Nutrition Information Center, USA

estimation of carbohydrate effects, carbohydrate exchanges, portions/servings, low glycaemic index or a qualitative approach (41,42). There is no consensus in favour of one particular method and some methods are better suited to particular children and families. What is becoming clearer is that if we are aiming at really tight metabolic control to improve diabetes outcomes there seems to be a need for some form of carbohydrate estimation to counter-balance insulin doses (4).

The significant *diet behaviours* associated with improved HbA1c in the DCCT (40) were:

- Adherence to the agreed meal plan
- Adjusting food and insulin in response to hyperglycaemia
- Appropriate treatment of hypoglycaemia
- Consumption of agreed snacks within the meal plan

The DCCT also showed that intensive nutrition education, not necessarily carbohydrate assessment, with frequent blood glucose monitoring in conjunction

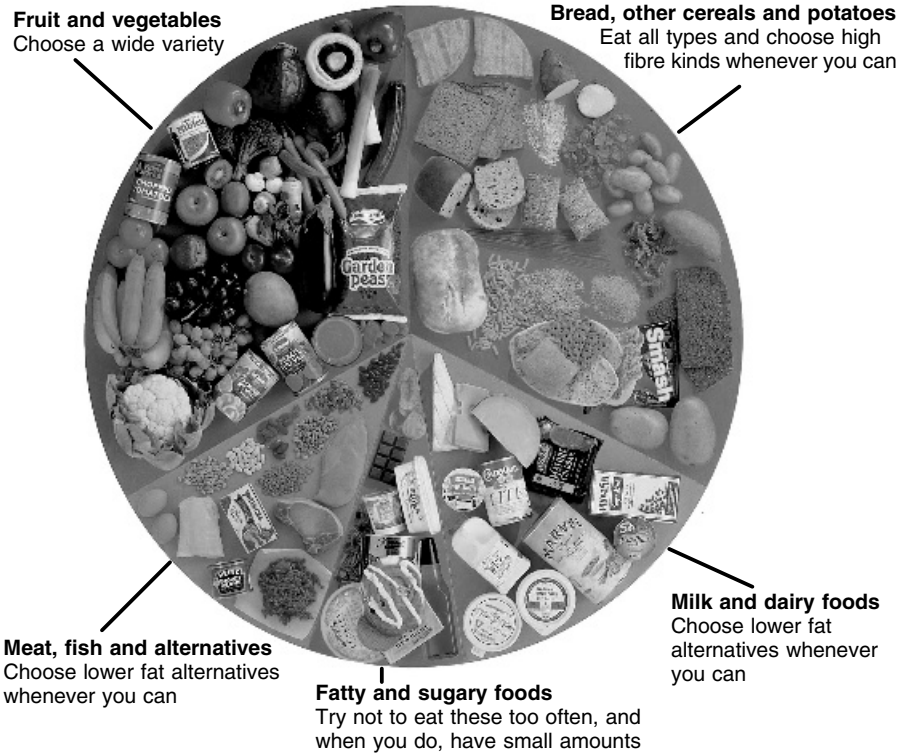

Figure 5.2 Plate model. Modified from: ©Diabetes UK. This figure has been reproduced with the kind permission of Diabetes UK. Adapted February 2001, from the Balance of Good Health: Food Standards Agency

with adjustment of insulin doses on a meal-to-meal and day-to-day basis, improved glycaemic control. This requires motivation, recording blood glucose results and altering insulin doses according to experience and often using an insulin adjustment algorithm. Moreover, the evaluation of intensified nutrition education programmes using carbohydrate assessment techniques in adults (43,44) has produced very good glycaemic outcomes.

Carbohydrate Assessment

The necessity and efficacy of using some form of carbohydrate assessment to achieve optimal glycaemic control is still hotly debated and questioned (4,45). In the past, exchange diets or carbohydrate portion systems were used rigidly, the person with diabetes was expected to eat the same amount of carbohydrate per meal or snack to balance their prescription of insulin and the patient was not encouraged to adjust their own insulin doses (46). Understandably, dietary adherence to such a system was poor (47–49) and made no allowances for diversity of energy expenditure (50) and growth. Also unless rigorously reviewed there was the danger that such dietary 'prescriptions' would lead to carbohydrate constraint as the child was growing, resulting in restricted growth and creating abnormal eating practices that are detrimental to normal family functioning (51). These dysfunctional approaches to eating may also contribute to disordered eating behaviours or eating disorders (52,53).

Most traditional teaching methods include some form of estimating or counting of carbohydrate. This may place misguided emphasis on quantifying carbohydrate and may alter the nutritional balance of the diet compared with non-diabetic peers. The subsequent suppression of carbohydrate then causes an increase in total fat (48,49,54,55) and potentially increases cardiovascular risk factors. Therefore whatever the educational method used there must also be a consideration of the balance of all the major nutrients.

The fundamental paradigm for carbohydrate education is the development of an understanding of the relationship between food and the post-prandial meal effect. This has to involve pre- and post-prandial blood glucose testing. The child and parents then need to be taught the skills to interpret the blood glucose tests and adjust insulin accordingly if optimal glycaemic control and a reduction in complications is to be achieved.

Optimal metabolic control as assessed by the level of glycated haemoglobin (HbA1c) is the gold standard of monitoring treatment of diabetes and the only evidence-based risk factor for future microvascular complications (17). However the DCCT (56) also suggests that post prandial glycaemic excursions play a significant role in increasing the risk of complications. This evidence supports a symbiotic link between the nutritional management of diabetes, blood glucose monitoring and insulin adjustment. Thus all three elements must be considered together.

Carbohydrate Assessment Methods

The following are descriptions of methods used to assess carbohydrate and their application will depend upon the preference of the child and family and their changing needs.

Carbohydrate Counting

Modern carbohydrate counting is a meal planning approach that focuses on improving glycaemic control and allowing maximum flexibility of food choices, so is especially suitable for children and young adults. Three levels of carbohydrate counting have been identified by the American Dietetic Association and can be considered as a stepwise approach (57,58).

- *Level 1* – basic, and introduces the 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 that contain all types of sugars and starches. Allowing a greater variety of carbohydrate foods (based on knowledge of the glycaemic index) than was previously accepted. With a regular carbohydrate intake and the results of blood glucose monitoring it is then possible for the dietitian, diabetes specialist nurse or doctor to advise on the appropriate insulin dose.
- *Level 2* – the intermediate step, in which the individual continues to eat regular carbohydrate and frequently monitors blood glucose levels, but learns to recognise patterns of blood glucose response to carbohydrate intake modified by insulin and exercise. They learn to make their own adjustments to insulin doses, or alter carbohydrate intake or timing of exercise to achieve blood glucose goals. Alterations of insulin should be made in response to a pattern of blood glucose results over a few days not based on a single high or low blood glucose.
- *Level 3* – for people on multiple injections or insulin pumps, requires a good understanding of the first two levels and motivation to closely monitor blood glucose levels. Once the appropriate insulin doses have been established on a regular intake of carbohydrate, an insulin/carbohydrate ratio can be calculated, e.g. 1.5 units rapid-acting insulin = 15 g carbohydrate exchange for additional carbohydrate. With this insulin/carbohydrate ratio the patient can begin to vary the amount of carbohydrate eaten at any particular meal and increase or decrease the insulin dose keeping the same ratio. This provides greater dietary flexibility than a traditional exchange diet and helps reduce the frequency of hypoglycaemia as well as high blood glucose levels after large meals.

The carbohydrate counting system at level 3 requires intensive education, extensive reassessment by an experienced dietitian and highly motivated

patients. However levels 1 and 2 may assist in achieving better compliance and improved blood glucose control when not using multiple injection regimens (59).

Glycaemic Index (GI)

See Chapter 11.

Qualitative Advice

The evidence base behind using the exchange system has been questioned as above and some studies have recommended a less prescriptive qualitative approach (48,49). This dietary education method is distinctly different from the 'free' diet. It has all the qualities of healthy eating principles plus a clearly defined carbohydrate structure to the meal plan. Studies have shown that children who follow this type of advice have comparable glycaemic control to children who follow exchanges (48,49), although in these studies glycaemic control was far from optimal and the DCCT has shown the significant benefits of intensive management. A recent study also showed reasonable glycaemic control in a group of children that had received qualitative advice from diagnosis (23). Although it appears reasonable glycaemic control can be achieved using this method the negative aspect is there is no mechanism to prevent post-prandial blood glucose excursions.

Intensive Nutrition Education

A programme of intensive nutrition and insulin management has *not* been widely used in the UK up to the present time but it has been positively evaluated in some European centres in adults with Type 1 diabetes (43,44). It encourages self-management and is based upon changing insulin doses according to blood glucose monitoring and assessment of carbohydrate at each meal and snack. A recent pilot study has taken place in the UK in adults with Type 1 diabetes, called the DAFNE (Dose Adjustment For Normal Eating) Study (60). It involves a five-day outpatient skills-based training and treatment programme. The feasibility of this programme in children and adolescents with diabetes is being considered at the present time and the results will be crucial in finding out whether it is possible with this regimen to improve glycaemic control in children and adolescents with diabetes in the UK.

One of the concerns of this approach is the potential increase in hypoglycaemia as demonstrated by the DCCT where the intensive group had a threefold increase in the rate of hypoglycaemia (17). However, later paediatric studies have shown that good glycaemic control can be achieved without adversely affecting hypoglycaemia rates (59,61). The careful balancing

of nutritional intake to insulin therapy was one of the important conclusions of the DCCT analysis and it seems clear that regular dietary re-education is essential when intensified management is introduced.

Insulin Types, Regimens and Action Profiles

General advice on balancing carbohydrate intake against the insulin action profile:

- Regular and frequent carbohydrate intake is advisable to prevent hypoglycaemia during inevitable periods of hyperinsulinaemia when the insulin regimen is twice daily mixtures of quick- and slower-acting insulins.
- A more flexible carbohydrate intake is possible when the insulin regimen is of multiple pre-prandial doses of quick or rapid-acting insulin.
- Carbohydrate intake is required before bedtime to prevent nocturnal hypoglycaemia in most insulin regimens.
- Extra carbohydrate is required before, during and after increased exercise and sport to balance increased energy needs and prevent hypoglycaemia.
- A 'grazing' or 'little and often' style of eating, often seen in younger children, may be suited to an insulin regimen consisting mainly of longer acting insulins.
- Flexible carbohydrate intake is possible when prandial boosts of insulin are given on multiple injection regimens or during continuous subcutaneous insulin infusions (CSSI 'pump treatment').

Insulin Analogues

Advice on balancing the insulin against an estimated carbohydrate intake has become more relevant and precise since the introduction of insulin analogues and CSSI management. The two rapid-acting insulin analogues currently available, lispro and aspart, have benefits over conventional soluble insulin:

- Very rapid onset of action within 10–15 min of subcutaneous injection
- A time action profile reducing the post-prandial blood glucose excursion
- Shorter duration of action reducing later hypoglycaemia several hours after insulin injection, including a reduction in nocturnal hypoglycaemia

However, it has become clear that to improve overall glycaemic control by the use of rapid-acting analogues, the slower-acting insulins also have to be carefully adjusted, and this may be made easier with the introduction of the newer longer acting analogue insulins.

In children the rapid-acting analogues are proving useful when:

- Injected *after a meal* when a young child's food intake is unpredictable
- Given as opportunistic extra doses when a child binges to satisfy hunger

- Injected as a calculated dose for particular levels of hyperglycaemia (it is useful to give specific guidelines on extra doses for particular levels of hyperglycaemia in relation to the age of the child – see below)
- Used in the evening instead of conventional soluble insulin to avoid nocturnal hypoglycaemia
- Used as a regular third injection after school to accommodate large volumes of food eaten at this time
- Used to reduce hyperglycaemia and ketosis in the management of intercurrent illnesses

Physical Activity

Physical activity in young people with or without diabetes is erratic and unpredictable: it is often spontaneous, usually unplanned and varies enormously in duration, type and intensity. Although regular physical activity and sports are highly recommended in all children and especially those with diabetes, the effects on glycaemic control are highly variable and difficult to manage. There are also great inter-individual differences with regard to physical activity and adjustments of both insulin and carbohydrate intake will be necessary to prevent hypoglycaemia which is a common complication (50,62). Intensive blood glucose testing is strongly advised at the beginning and after each new activity to develop some understanding of the relationship between the required insulin and the amount and type of food to sustain reasonable blood sugar levels.

The blood glucose-lowering effect of heavy exercise may occur several hours after the cessation of physical activity. The possibility of such late post-exercise hypoglycaemia should be remembered when planning meals and snacks. Insulin may need to be reduced and/or carbohydrate increased.

'PREVENT HYPO- AND/OR HYPERGLYCAEMIA DUE TO INSULIN, ILLNESS AND EXERCISE'

Hypoglycaemia

There seems little doubt from personal experience and studies such as the DCCT and others (59,61) that repeated expert dietetic advice as part of comprehensive diabetes management can reduce the incidence of hypoglycaemia. In contrast if diet is ignored as a major determinant of control and especially in extreme activity, hypoglycaemia rates can be worryingly high (50,64).

Guidelines (verbal and written) both for prevention and treatment of hypoglycaemia should be available soon after diagnosis with particular emphasis on regular carbohydrate intake. Hypoglycaemia should be discussed frequently at clinic appointments and investigated with respect to poor dietary

management. Moreover if parents and other carers are given clear guidelines on how to treat with urgency episodes of severe hypoglycaemia, the frequency of hospital admissions may decrease to very low levels.

The dietitian should be able to supply useful information in relation to sport, exercise and travelling with diabetes, all of which require careful planning and organisation. Increased blood glucose monitoring (before and 2 h after) is advised for new activities. Nocturnal hypoglycaemia in relation to new activities, long duration and intense exercise should be discussed and changes in treatment may be necessary. The options for change may be either a reduction in insulin or increasing carbohydrate intake, and often both are necessary (50). Educational holidays (76,77) such as those organised by Diabetes UK are a rich source of education for dietitians with respect to planning outings, travel, preventing and treating hypoglycaemia, and arranging meal times to suit a variety of activities.

Hyperglycaemia

One of the most significant diet behaviours in the DCCT that reduced HbA1c was 'adjusting food and/or insulin in response to hyperglycaemia' (40). Dietetic advice should include an appraisal of the usual carbohydrate intake of the day in relation to blood glucose monitoring (BGM). Advice on timings of BGM will be necessary with the aim of developing the child's and parents' understanding of the glycaemic effect of different carbohydrates. The availability of rapid-acting insulin analogues has improved the management of isolated episodes of hyperglycaemia. Due to its short action profile parents feel confident about using these analogues, especially later in the evening. Also these insulins can be used prior to foods known to have a hyperglycaemic effect in the individual child.

Guidelines for extra rapid-acting insulin given for isolated high blood glucose levels or prior to extra carbohydrate loads are as follows:

Age	BG > 15 mmol/l	BG > 17 mmol/l	BG > 20 mmol/l
< 6 years	0.5–1.0 units	1–2 units	2–4 units
6–12 years	1–2 units	2–4 units	3–6 units
> 12 years	2–4 units	3–6 units	5–10 units

These doses may be repeated after 2 h if the BG shows no significant decrease.

Illness

The dietitian along with the diabetes care team should provide clear guidelines on managing diabetes during intercurrent illnesses. Normal food intake may be

dramatically reduced and easily digested carbohydrate foods should be offered. It may be necessary to substitute food completely with sweet liquids during complete food refusal. Frequent BGM is essential during this period and adjustment of insulin may be necessary. Insulin should never be stopped but may be increased or decreased depending upon the type of illness and the results of BGM. It is important to recognise the childhood illness that is most likely to cause hypoglycaemia is gastroenteritis with vomiting and diarrhoea. Most other infections with fever cause hyperglycaemia. Written guidelines for 'sick days' are helpful and reassurance is often necessary during these troublesome episodes, especially when a young child will not eat. Adequate fluid intake is essential during hyperglycaemia and fever to prevent dehydration.

'REDUCE THE RISK OF LONG TERM MICRO- AND MACROVASCULAR COMPLICATIONS THROUGH OPTIMUM GLYCAEMIC CONTROL'

The most significant contribution to proving that a reduction in glycated haemoglobin is associated with a reduced risk of microvascular complications in adolescents with Type 1 diabetes was the DCCT (17). The DCCT enrolled 195 adolescents (13 to 17 years at entry) into the trial, 14% of the total participants: 125 with no retinopathy at baseline were recruited (primary prevention cohort) and 70 subjects with mild retinopathy (secondary intervention cohort). In the primary prevention cohort, intensive therapy decreased the risk of retinopathy by 53% in comparison with the conventional group. In the secondary intervention cohort, intensive therapy decreased the risk of retinopathy progression by 70% and the occurrence of microalbuminuria by 55%.

Dietary analysis of the DCCT confirmed the value of *regular* dietary advice and education (63).

'REDUCING THE RISK OF MACROVASCULAR COMPLICATIONS'

High Morbidity and Mortality in Young People with Diabetes

Young people with Type 1 diabetes diagnosed under the age of 30 years have an increased risk of cardiovascular disease. They suffer two to four times higher mortality compared with their peer group and cardiovascular disease is responsible for the majority of deaths above the age of 30 years (5). There is also increasing evidence that macrovascular changes may be present in young people with Type 1 diabetes (65,85). Promoting cardiovascular health is essential from the day of diagnosis.

Achieving Diabetes Nutritional Recommendations

The aetiology of cardiovascular disease is multi-factorial and nutritional intake is only one component. Dietary fats, especially saturated fats, play a key role and the importance of cardio-protective factors such as antioxidants is emerging. The combination and balance between other nutrients and all components of the dietary recommendations are important (1–3,31).

Although the total fat intake of children in the UK has decreased over the last decade (22) children with diabetes still appear to find it difficult to achieve diabetes recommendations (23) and total fat intake remains above recommendations. The indigenous diet of the UK and the unhealthy snack choices made by children may be responsible for this (32). Dorchy and Bourguet (66) also report the difficulty in reducing total fat even with intense dietary education. In comparison other countries report low fat intakes in children with diabetes, (67–72). However even with low fat intakes the fatty acid composition of the diet may not be ideal. Pinelli *et al.* (67) reported the ideal profile, saturated fat 8%, monounsaturated fat 21% and polyunsaturated fat 4% of total energy. The study by Donaghue *et al.* (31) shows how a diet rich in monounsaturates changes the lipid profile, and cell membrane characteristics would appear to be important. Children in the general population in the UK have a very poor profile with high saturated fat levels of 14% (22), and studies in children with diabetes also reflect this pattern (68,69,71,72,73). The importance of saturated fat in relation to cholesterol and LDL as cardiovascular risk factors suggests nutrition education should focus not only on total fat but also on the fatty acid profile. Due to the eating style of the average UK child this may be difficult to achieve. It is helpful therefore to give parents practical advice on identifying those foods with a high saturated fat content and to suggest lower fat (and palatable) alternatives.

Careful evaluation of the efficacy of education programmes along with prospective, randomised controlled trials in relation to dietary modification and cardiovascular risks are urgently needed.

PRESERVE SOCIAL AND PSYCHOLOGICAL WELL-BEING

Psychosocial Aspects of Meals and Food Intake

Food is often seen as the major issue for parents. The child has a great opportunity for aggravating and manipulating parents through food refusal. It is important that the family is encouraged to treat the child with diabetes and siblings the same from the first days after diagnosis. Virtanen *et al.* (74) have shown positive dietary changes can occur throughout the whole family due to the presence of a child with diabetes and therefore recommend that advice should be directed at the whole family from the beginning. Some parents will resist this because they do not want to deny siblings previous (often excessive)

intake of sweets, chocolates and sweeter foods. This approach will cause feelings of isolation and stigmatisation. These feelings may also be acutely felt when with the child's peer group, especially in the school surroundings. The child is often embarrassed to eat snacks when other children are not allowed to, sometimes resulting in hypoglycaemia. The school timetable should be examined carefully and snacks placed within natural school breaks if possible. The teachers and lunch supervisors need instructions on the importance of regular carbohydrate and the individual child's signs and symptoms of hypoglycaemia and action to take if hypoglycaemia occurs. The 'School Pack' designed by Diabetes UK is useful in this context (75).

It is most unfortunate that the trend in the UK is not to eat meals at the family table with parents and siblings. Good eating habits are therefore not encouraged. It is important to counsel families, encouraging them back to more traditional eating patterns and to establish better supervision, communication and enjoyment at family meals.

Infants and Toddlers

Breast feeding is to be encouraged with infants diagnosed with Type 1 diabetes. Frequent small meals in infants and toddlers are compatible with good overall glycaemic control, especially when a long-acting insulin is the main insulin prescribed. In toddlers, eating as a family may help promote greater co-operation at meal times. Providing suitable foods with a variety of tastes, colours and textures can also improve a toddler's compliance with their diet. Of course this age group is renowned for food refusal and food fads, which is extremely anxiety provoking for the parent. This situation requires delicate handling because the child can hold the parent to ransom by refusing to eat and consequently parents 'give in' to the child and a poor dietary intake is established. Behaviour tactics are necessary; the parent should not get into conflict over these problems or give in to demands. Insulin analogues are extremely useful in this situation, especially given after the child has eaten.

School Children

Advice on prevention of disruptive, confidence-shattering hypoglycaemia is most important. School staff should be aware that children with diabetes need quick and easy access to food at all times, and this especially includes periods related to physical activity. Specific holiday and travel advice should be made available. Unfortunately, some schools continue to exclude children with diabetes from excursions and holidays and this needs to be assisted by health care professionals who can help by providing responsible advice to parents and teachers.

Young people with diabetes (and dietitians) may learn greatly from the experience of attending either local or nationally organised educational holidays (76,77). They are extremely useful educational events where skills can be developed in adjusting carbohydrate and insulin around different activities.

Adolescents

The normal physiological, psychological and metabolic changes of puberty are often associated with poor glycaemic control. Insulin requirements usually increase greatly with the physiological increase in insulin resistance and rapid growth. There is a tendency for excessive weight gain, particularly in girls. Careful review of insulin dosage, energy input and output is advisable throughout adolescence. Excessive weight gain may result from attempts to obtain excellent glycaemic control by matching insulin requirements with food intake. Weight monitoring is important for both the early recognition of excessive weight gain and also weight loss, as this can be the first sign of a potential eating disorder. Delayed puberty and poor linear growth may be an indication of insufficient energy intake, inappropriate insulin and/or poor glycaemic control. All children must have regular height as well as weight monitoring and be plotted on appropriate growth charts. While a degree of rebellious behaviour is usual in all adolescents it can be dangerous in diabetes when associated with failure to take insulin and erratic eating behaviour (7,79). Access to expert psychological support and counselling should be available. All adolescents should receive advice on the potential dangers of excessive alcohol intake.

Eating Disorders

The incidence of eating disorders in adolescent girls with diabetes is higher than that in the non-diabetic population and its incidence is increasing (79). This may be partly a consequence of intrusive dietetic management of diabetes at an earlier age. In association with eating disorders, the omission of insulin is a well-described tactic in attempts at weight loss in overweight insulin-treated patients (80,81). Individuals with eating disorders have higher HbA1c levels and an earlier age of onset of diabetic complications, one study reporting that eating disorders were associated with a threefold increase in risk of diabetic retinopathy (79).

It is not only teenage girls with eating disorders who require additional support but all teenagers are potentially vulnerable as there is some indication that binge eating and misuse of insulin is common among both teenage boys and girls. Evidence from the Young Diabetes Conference in 1987 indicated that

71% of young people with Type 1 diabetes admit to 'binge' eating which is often associated with feelings of extreme guilt (78).

The Acheson Report recommended 'policies which promote the adoption of healthier lifestyles, particularly in respect of factors which show a strong social gradient in prevalence or consequences' (82). Eating disorders have serious consequences for metabolic control and consequent acceleration of the onset of complications. They are also an indication of mental health problems requiring psychological support (82). There is a need to research effective methods of tackling these problems; to train health care professionals to deal with eating disorders. This will inevitably require sufficient resources. Indicators that could be used to show effective treatment are increased uptake of insulin usage, better glycaemic control and fewer admissions with diabetic ketoacidosis.

Parties, Festivities and Special Events

Children with diabetes should be encouraged to attend and participate in all family, social and religious events to which their non-diabetic siblings and friends are included and not to hide behind their diabetes. Special dispensation is usually given to children with diabetes during fasts such as Ramadan. Parents are recommended to advise other parents and care givers on their child's food preferences including low-sugar drinks. Occasional sugary food treats may not cause hyperglycaemia if physical activity levels are also high. To prevent or treat hyperglycaemia resulting from social events that include unusual amounts of eating, the use of additional short or rapid-acting insulins may be useful (see extra insulin guidelines above). As with all age groups, friends and other care givers should know how to recognise and treat hypoglycaemia.

DIABETES IN CHILDREN AND ADOLESCENTS NOT DUE TO TYPE 1 DIABETES

Type 2 Diabetes

Non-insulin-dependent, non-immune-mediated Type 2 diabetes has always been considered rare in children. However, in Japan it is more common than Type 1 diabetes and has increased greatly in incidence in the last two decades (83). Also in recent years in certain paediatric populations in the USA Type 2 diabetes has accounted for up to 45% of newly diagnosed diabetes (9,10) and there is evidence that this type of diabetes is now on the increase in the UK (11). The highest risk groups for Type 2 diabetes in youth are obese, physically inactive, female adolescents with a family history of diabetes, particularly from ethnic minority communities (12,13).

In adults, Type 2 diabetes is difficult to manage and there is a high reported incidence of serious vascular complications. Its emergence in adolescence is therefore a major public health concern, particularly as in this age group non-adherence in terms of clinic attendance and treatment regimens is common (7).

An essential component of nutritional management is a review of eating habits and lifestyle, and almost always there will need to be both a reduction of energy intake and an increase of physical activity to promote weight loss. Unfortunately these behavioural changes present major obstacles to effective education. Close surveillance will be necessary and if weight loss does not occur with simple healthy eating advice more detailed advice should be given on energy reduction. Nutritional advice will depend on the type of treatment prescribed and advice given on hypoglycaemia if necessary.

Carefully organised multicentre trials of lifestyle management and interventions amongst young people are required (84).

DIABETES SECONDARY TO CHRONIC DISEASES OF CHILDHOOD

Cystic Fibrosis (CF)-related Diabetes

As life expectancy in CF improves, slowly evolving, non-ketotic, glucose intolerance and diabetes is becoming more frequent (14). The diabetes is predominantly due to insulin deficiency but there are elements of insulin resistance and, because of co-existing pancreatic exocrine deficiency, there is a need for high-energy, complex carbohydrate and high-fat foods which conflicts with the usual advice for diabetes in terms of cardiovascular risk.

Moreover it is common practice in CF to use overnight gastrostomy feeds to improve nutrition and steroid therapy is often prescribed. Both of these increase glucose intolerance (and may initially precipitate diabetes). Alterations of food intake and absorption and constantly changing treatments demand flexibility in both nutrition education and insulin regimens, especially as the diagnosis of diabetes in addition to CF is particularly demoralising.

Haemoglobinopathies

Treated β-thalassaemia with chronic iron overload is associated with decreasing tissue sensitivity to insulin, pancreatic insulin deficiency and diabetes (15). Insulin doses may be high and the diabetes difficult to manage as in CF because of the double diagnosis. Chronic glycosuria may be associated with poor weight gain and effective nutritional management becomes important in trying to persuade patients to increase energy intake in association with escalating insulin doses.

Genetic Defects of β-cell Function

This group of rare disorders was formerly known as maturity-onset diabetes in the young (MODY) and comprises at least six subtypes of genetically inherited disorders of insulin secretion usually presenting under the age of 25 years and also present in several other family members in different generations (16). It is important to recognise the small number of this unusual and 'mild' type of diabetes in a paediatric clinic (confirmed by special tests in a molecular genetic laboratory) because of the treatment implications.

The two commonest types are:

- *Glucokinase deficiency* (25% total) – a defect in the glucose-sensing gene resulting in mild persistent hyperglycaemia from birth, but with a very low risk of long-term complications. The only treatment required is healthy eating advice to improve levels of glycaemia.
- *HNF-1α deficiency* (55% total) – involves progressive β cell failure from puberty, managed initially by healthy eating advice like Type 2 diabetes but subsequently treated with low dose sulphonylurea tablets and later insulin so that nutritional advice on hypoglycaemia as described elsewhere is required.

SUMMARY

The care of children with diabetes is complex. It involves not only the child but also the family and multiple carers. 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. In addition diabetes management is set within the current context of frequently dysfunctional family dynamics, deteriorating national dietary characteristics, issues of non-compliance, peer pressure, emerging independence and the ultimate aim of maintaining quality of life. However evidence suggests it is possible to improve diabetes outcomes through meticulous attention to nutritional management. This requires a clear focus of the dietetic targets in relation to glycaemic control and the reduction in cardiovascular risk.

The fundamental premise of success for the paediatric diabetes specialist dietitian is the development of a trusting relationship between the child and family, which will facilitate behaviour change during the challenges and turbulence of childhood and adolescent development.

LOOKING TO THE FUTURE

The management of childhood diabetes will continue to present special challenges to all members of the paediatric diabetes team. These challenges are perhaps greatest for the dietitian whose success depends so much on trying to promote significant changes of behaviour related to food, eating and weight control. All of these areas of human behaviour are notoriously resistant to change, particularly in adolescents and family groups.

Despite these difficulties there will be developments in management that should improve the prospects for the dietitian. Specialist paediatric diabetes dietitians will have more specific and extensive training and will become a more effective member of the multi-disciplinary diabetes team. With better training the knowledge base in both paediatrics and diabetes will increase and be more practical. Also the skills to effect behaviour change, which include counselling, motivational interviewing and the ability to be flexible by using various education tools to suit different families, will be far more extensive than at present. Better communication between team members will be seen as essential in providing comprehensive, co-ordinated professional support and optimal care of the child and family.

Nutritional management will have targets more clearly linked to the two major diabetes outcomes of maintaining much tighter glycaemic control associated with a substantial reduction in microvascular complications and far better prevention of cardiovascular disease.

The highly trained and experienced dietitian will have an extended role in the team and will be confident not only to advise on food changes but also to help adjust insulins to reduce post-prandial blood glucose excursions. These adjustments will become more flexible and appropriate because of more frequent use of rapid-acting insulin analogues, continuous insulin infusions and perhaps other modes of insulin delivery such as inhaled insulin.

Methods of continuous monitoring of blood glucose will become easier and more sophisticated so that the glycaemic effects of certain types of carbohydrate intake will become more readily apparent to the child and family.

Thus the devolution back towards carbohydrate assessment or measurement in some form will continue so that a more precise balance between food and insulin can be achieved.

It has become clear that the specialist paediatric diabetes dietitian must also focus attention on reducing cardiovascular risk factors. Evidence is accumulating that increases in anti-oxidants and modifications in fatty acid intake may induce beneficial changes in cell membranes and these changes must be initiated in childhood to minimise the progression of atherosclerosis.

These are exciting innovations but unfortunately they are set against a nutritional environment in the UK which encourages unhealthy eating

practices with increasing reliance on high-fat, high-salt fast foods, disorganised family eating patterns and even a reluctance by many influential agencies to promote healthier eating along the lines of those in some other areas and countries such as around the Mediterranean and Scandinavia.

To counterbalance this the dietetic community must improve the scientific evaluation of dietary practices by more extensive and better research. In paediatric practice where numbers are relatively small this can only be achieved by well-structured, multi-centre projects similar to DCCT and DAFNE (see above).

To enable all these exciting changes in practice to come to fruition there will need to be a recognition by health authorities that specialist paediatric diabetes dietitians are an important investment in the future of children with diabetes. It is then essential that there is more adequate resourcing for paediatric centres of excellence to be established as specialist training centres.

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