The Diet in Diabetes

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Nutritional considerations for the diabetic include weight control, an adequate intake of essential nutrients, attention to food factors which modify blood glucose and blood lipids and, for compliance, the social function of food

Optimal nutritional status is an important object of treatment for diabetics of all age groups. For children and adolescents, it will allow normal growth and development. In the pregnant and postnatal diabetic woman, satisfactory fetal development and lactation, respectively, will occur. For the adult, desirable bodyweight will be maintained with the likelihood that the nutritionally related disorders will be minimised.

Goals more specific for the diabetic are the avoidance of acute and chronic diabetic complications. When normal blood glucose concentrations are achieved, hypoglycaemic episodes and hyperglycaemia with hyperosmolality or ketoacidosis are avoided. While euglycaemia may reduce the likelihood of microvascular disease, the relationship between blood glucose control and macrovascular disease is more uncertain. Control of serum cholesterol, triglyceride and high density lipoprotein concentrations are possibly more important than blood glucose control in terms of macrovascular disease. Nutritional management makes an important contribution to blood glucose and lipid control in addition to the attainment of desirable bodyweight.

Nutritional Priorities for the Diabetic

At diagnosis, diabetics, whether insulin-dependent (type I) or maturity onset (type 2), are often removed from their ideal bodyweight. Weight is an important clinical guide to energy balance, and attainment of ideal weight requires attention to control of all the energy components of food — carbohydrate, fat, protein and alcohol.

It is a fundamental nutritional principle that the wider the variety of food items in the diet the more likely is the intake

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Points in Brief

Nutritional priorities for the diabetic

1. Attain a desirable bodyweight.
2. Ensure an adequate intake of all essential nutrients.
3. Maintain a normal blood glucose.
4. Reduce blood lipids to normal.
5. Allow for the social function of food.

of essential nutrients to be adequate. Another value of such a dietary approach is that harmful factors in food (e.g. cyanide compounds in tapioca and kernels) will be diluted in the total food intake when coming from only one of many items.

Both the need for and the techniques by which a normal blood glucose can be maintained in the range of 3.5 to 7.5mmol/L are now better appreciated. The advent of self-monitoring of the blood glucose, for the first time, allowed for home assessment of control below the renal threshold. It is now possible for the diabetic to assess the effect of a particular dietary change on his own blood glucose level. Self-monitoring enables the patient to gain greater insight into his pattern of diabetic control and the importance of diet in maintaining it.

While the patient can now take charge of monitoring his weight and blood glucose, the responsibility to review his blood lipid status from time to time (usually on a yearly basis) remains with his medical attendant. The importance of dietary fat for diabetics may be seen in populations (e.g. Japanese) where diabetics have a low prevalence of ischaemic heart disease and a low fat intake derived principally from vegetable and marine sources. For diabetics exposed to traditional Western diets, and who have elevated blood lipids (cholesterol greater than 6.5mmol/L or triglycerides greater than 2.0mmol/L), it would seem prudent to attempt to reduce these values by dietary methods such as a reduction in total fat and an increase in the polyunsaturated to saturated fat in the diet. Excess bodyweight and alcohol also contribute to hyperlipidaemia in the diabetic as they do in non-diabetics.

Food has many non-nutritional functions such as facilitating social intercourse, allowing mood alteration, and subserving religious and philosophical needs. Food culture is also a particularly important consideration in a multicultural community. The social function of food must, therefore, be taken into account if compliance is to be expected.

Food Factors Affecting Blood Glucose

The many known factors of food that can potentially affect blood glucose (table I) highlight the oversimplification of attempting to predict the blood glucose response to a food from its total carbohydrate content. The physical properties of food are important and particle size and viscosity have been shown to affect the blood glucose response to food.

Much has been made in the past of whether or not the dietary carbohydrate is a polymer like starch or a simple sugar like sucrose or glucose. It does not appear that the chain length of the carbohydrate affects either the rate or the extent of absorption. Furthermore, recent work suggests that when the dietary carbohydrate increases, there is increased production of pancreatic amylase to ensure digestion of the additional carbohydrate. Restriction of dietary carbohydrate has long been known to impair glucose tolerance, and in an international study an inverse association between the proportion of energy from carbohydrate in the diet and the prevalence of diabetes has been observed [1]. The true value of a higher carbohydrate

TABLE I. Properties of food affecting blood glucose

1. Physical
   a) Particle size.
   b) Viscosity.
   c) pH (?).
2. Absorbable carbohydrate
   a) Monomeric components (glucose, fructose, etc.).
   b) Relative contribution to energy intake.
3. Dietary fibre
4. Non-carbohydrate macronutrients
   a) Protein.
   b) Fat.
5. Micronutrients
   a) Chromium.
   b) Zinc.
6. Hypoglycaemic factors
   a) Ethanol.
   b) Hypoglycin.
   c) Bongkrek acid.
7. Enzymes and enzyme inhibitors

diet in improving diabetic control is better appreciated over a period of several weeks.

Apart from invert sugar in which glucose and fructose are present as monomers in the same proportion as they are in sucrose, it is unusual to ingest significant amounts of glucose, although it is glucose that is commonly used for assessment of carbohydrate tolerance. Fructose is more commonly found in food than glucose and, when ingested, results in lower blood glucose concentrations. More needs to be known about the effects of sucrose and other naturally occurring disaccharides such as lactose on blood glucose concentrations when they are eaten as part of a normal meal.

Dietary fibre or non-absorbable carbohydrate can reduce the peak blood glucose response when coingested with glucose. However, dietary fibres are a diverse group of macromolecules (commonly polysaccharides) with differing properties. Most of the studies have examined guar (derived from an Indian legume) and pectin added to simple carbohydrate feeds. The relevance of these studies to the effect of dietary fibre in intact food on the modulation of blood glucose concentration is uncertain. The cellulosic and hemicellulosic fibres commonly found in the Western diet may not be as effective as guar in attenuating the blood glucose response to a meal. On the other hand, the storage fibres found in legumes which are available in Australia do appear to be more effective.

The major components of food which are most overlooked in terms of blood glucose control are the non-carbohydrate macronutrients protein and fat. Early physiologists observed that gastric emptying was modified by the ingestion of protein and fat. These macronutrients also modify insulin secretion. Both factors are important considerations in blood glucose modulation after a meal.

For many years it has been known that chromium or the chromium-containing glucose tolerance factor can, in some individuals, modify blood glucose concentration as well as plasma insulin levels. The studies so far reported have been mainly North American and it is not known whether the background chromium intake against which supplementation studies in North America have been done is in any way comparable to the intake in Australia or New Zealand.

There are also hypoglycaemic factors in food such as hypoglycin from the ackee fruit and bongkrek acid from fermented coconut foods contaminated with *Pseudomonas cocovenenans*. Enzymes and enzyme inhibitors which could affect carbohydrate digestion are also found in food.

Thus, there are many variables in our diet other than carbohydrate which affect blood glucose. It is therefore necessary to consider all these factors, including the longer term effects of intact foods or whole meals on blood glucose levels.

Alcohol in Diabetes

There are several reasons why it is important to evaluate and individualise the place of alcoholic beverages in the diabetic diet. Firstly, the energy value of the alcoholic beverage needs to be taken into account where weight control has been difficult. Secondly, the carbohydrate content of the alcoholic beverage will contribute to the blood glucose level. Thirdly, ethanol can induce hypoglycaemia. There are other psychological, social and organic effects of alcohol which must also be taken into account. The possibility that alcoholic beverages may contribute to hypertriglyceridaemia in some diabetics has already been referred to.

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It is of interest that alcoholic beverages may actually contribute essential nutrients to the diet, although this is probably more important with native beers from traditional cultures. An example of this is chromium, which is found in beer and is probably largely derived from brewers' yeast (*Saccharomyces cerevisiae*), the richest known source of glucose tolerance factor.

Diet and Exercise

Exercise can be valuable in several respects in diabetics [2]. For subjects with low levels of physical activity, appetite is decreased when regular physical activity is undertaken. Thus, aside from additional energy expenditure, reduced appetite with exercise should help weight control

Exercise also appears to improve insulin sensitivity and to lower glucose and lipid levels. Another benefit of regular physical exercise is that some energy-dense (kJ/g) foods can be eaten and compliance can thereby be improved.

Special Foods

Special foods for diabetics include low energy-dense items, foods sweetened without sucrose, and fat-modified foods (table II).

It is practical and less expensive for diabetics to use foods that are intended for the public at large provided that the principles of diabetic management are applied. Dietary advice should be oriented towards helping patients to choose from readily available foods.

It is important for diabetics to understand the difference between non-nutritive and nutritive sweeteners since those that are nutritive will contribute energy and not assist in weight control. It is a common misconception that products intended for diabetics, and often misleadingly labelled, will be low in energy density.

TABLE II. Special foods for diabetics

1. Low energy-dense (kJ/g) foods.
2. Foods sweetened without sucrose
   a) Non-nutritive (saccharin, cyclamate).
   b) Nutritive (fructose, sorbitol).
3. Fat-modified foods.

Diet and Age

Children with diabetes are growing and are often hungry. It is common for them to increase their energy intake with food items such as biscuits. To some extent this may be acceptable in so far as energy requirements must be met, but attention should also be given to replacing energy-dense by nutrient-dense (essential nutrients/kJ) foods.

The elderly diabetic with reduced energy requirements must err on the side of more nutrient-dense and less energy-dense foods such as whole grain cereals, vegetables and fruits.

Diet Therapy

Newer concepts in nutritional management of diabetes as well as advances in the other therapeutic approaches to diabetes have allowed more flexibility in diet. In particular, disproportionate carbohydrate restriction is not appropriate in any form.

Diet Alone

Where diet alone will be the management for a diabetic, the limited insulin reserve probably requires a more even distribution of carbohydrate intake to match insulin output to a particular glucose load. The relatively higher contribution to energy intake from carbohydrate now recommended not only allows a wide choice of food items from cereal products, vegetables and fruits, but also appears to enhance insulin sensitivity. Although Asian and Southern European diabetics may have daily energy contributions from carbohydrate of 70 to 90%, it is probably unrealistic for those with an Anglo-Saxon food culture to achieve relative percentage energy from carbohydrate of more than 55%. This is, however, a good deal more than the average of 40% found in Australia and considerably more than the levels of 30% or less found in some diabetics [3].

Diet Plus Oral Agents

With oral agents, much the same principles of dietary management apply as when diet alone is used. However, as insulin reserve may be more impaired, perhaps a stronger case can be made for increasing the proportion of daily energy from dietary carbohydrate. For both patients managed by diet alone and those requiring oral agents, control of daily calories remains of paramount importance.

Diet Plus Insulin Therapy

With insulin therapy, and especially with the newer insulin delivery systems such as subcutaneous infusion, it is often possible to tailor the insulin dose to a more individually desirable food intake pattern. Even without subcutaneous insulin infusion, twice daily insulin regimens including both medium acting and short acting insulin components allow diets to be developed initially according to personal requirements, and then insulin therapy can be introduced in relation to that food intake pattern. Only when it is not possible to optimise control at particular times of the day with insulin adjustments, is it necessary to modify food intake. Again, a high proportion of daily energy from carbohydrate will have desirable metabolic effects such as enhanced insulin sensitivity and reduction of blood lipid levels.

Nutrition Education

The diabetic requires a working knowledge of food composition, in the form of energy values, carbohydrate

and lipid content and nutrient density. It is now clearly insufficient for diabetics to know only about the total carbohydrate content of food although it can still be helpful for them to quantify this in some way. The most direct way of accomplishing this would be to know the number of grams of carbohydrate in a familiar serving size. Since not all sources of carbohydrate are the same, and as other food components are important determinants of blood glucose, a system of food exchanges appears to be a preferable approach to nutrition education for the diabetic than the portion system.

Home monitoring of the blood glucose could help further in allowing the diabetic to relate particular foods to his own blood glucose control. Equal emphasis should be given to total energy control, which requires knowledge of the energy content of familiar serving sizes. The involvement of a trained dietitian with the aid of well thought out visual aids is essential in this exercise.

The role of the clinician is to supervise the many aspects of management and to bring together the patients responsibility for his treatment and the dietitian's help with food selection.

Current trends in the nutritional management of diabetes suggest that improved patient compliance and metabolic control can be expected. □

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PATIENT MANAGEMENT

Practice Guide

Nutritional Management of the Diabetic Patient