

Symposium on ‘Recent developments in diabetes care’

The evolution of the nutritional management of diabetes

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Diet and lifestyle advice for individuals with diabetes has changed dramatically. The changes in nutritional recommendations have largely been in response to advances in the knowledge of the biochemical and physiological mechanisms of impaired glucose metabolism and the micro- and macrovascular complications of diabetes. The most recent guidelines for the nutritional management of diabetes were set out by Diabetes UK in 2003. This consensus-based advice paper builds on the previous evidence-based review papers of the European Association for the Study of Diabetes in 2000 and the American Diabetes Association in 2002. The changes from previous recommendations include a more liberal use of sucrose, in line with healthy eating recommendations for the general population, and allow for greater flexibility in energy derived from carbohydrate and monounsaturated fat. In addition, monounsaturated fats are promoted as the fat of choice and active promotion of carbohydrate foods with a low glycaemic index is encouraged. These guidelines emphasise the practical application of nutritional management of diabetes and the need to provide education and support in a structured way that will facilitate change in diet and lifestyle behaviour. Structured educational programmes have been shown to be effective in reducing the progression to diabetes and also in slowing the onset and progression of the complications of diabetes. These programmes require ongoing intensive input to maintain behavioural change in diet and lifestyle. Considerable energy and resources are required to set up and maintain these educational programmes, but the cost per individual is small compared with the costs of treating the complications of diabetes.

Diabetes: Nutritional management: Diet and lifestyle: Educational programmes

The history of diabetes: a focus on nutritional management

The nutritional management of diabetes has had to adapt to many changes, including economic forces, changes in staple foods and eating patterns, new medications and insulin formulations, the availability of evidence-based research and improved knowledge in science and medicine. It is interesting to glance back through the changes in the nutritional management of diabetes to see what progress has been made and how much needs to be done to provide adequate diet and lifestyle advice and support for individuals with diabetes (Table 1; Sanders, 2001; Canadian Diabetes Association, 2004).

There have been huge changes over the years in the nutritional recommendations for diabetes. It is quite possible that nutritional recommendations in 100 years

time may once again be substantially different from the current recommendations.

Guidelines for the nutritional management of diabetes

In the past many theories have been offered on the appropriate nutritional and lifestyle recommendations for individuals with diabetes. Dietary advice is continually changing in response to advances in the understanding of the biochemical and physiological mechanisms involved in the complications of diabetes (Clinical Standards Advisory Group, 1994). The first position statement on diet and diabetes came from the British Diabetic Association (now known as Diabetes UK) about 20 years ago. The emphasis of these recommendations was on healthy eating principles in line with those for the general population, which thus

Table 1. Historical changes in the nutritional management of diabetes (Sanders, 2001; Canadian Diabetic Association, 2004)

Date	Progress achieved
1000 BC	Traditional Indian medicine noted two types of diabetes: one that occurred in thin young individuals; one that was common in the overweight
150 BC	The Egyptians were writing about diabetes in the papyrus scrolls. Their diagnosis was based on symptoms of polyuria. They devised what they thought to be a perfect treatment: 'a four-day course of ground earth, water, bones, wheat and lead'
45–117 AD	Ancient Greeks were the first to advocate diet and lifestyle management for individuals with diabetes. Aetius prescribed a 'cooling diet of diluted wine and cooling applications to be applied to the loins'. Avicenna directed that all diuretic foods and drugs be avoided and that patients engage in exercise (preferably on horseback) 'to employ moderate friction'. In the latter stages of diabetes he recommended 'tepid baths and fragrant wines'
18th century	Mathew Dobson and John Rollo observed that there was sugar in the urine and blood of individuals with diabetes. They believed that glucose was being lost and thus could not be used for nutrition
1813	Claude Bernard linked diabetes with glycogen metabolism
1816	L Taube related the intake of carbohydrate and its digestion to increased amounts of sugar in urine; thus, stopping the intake of carbohydrate eliminates most of the sugar from the urine
1850	French physician, Priory, advised patients with diabetes to eat extra large quantities of sugar to treat their diabetes
1870	French physician, Bouchardat, noticed the disappearance of glycosuria in his diabetic patients during the rationing of food in Paris while under siege by Germany during the Franco-Prussian war. He formulated the idea of individualised diets for his diabetic patients
Late 19th century	Italian diabetes specialist, Catoni, isolated his patients under lock and key in order to get them to adhere to their diets
1900–15	'Fad diets' included the 'oat cure' in which the majority of the diet was made up of oatmeal. Also noted are the 'milk diet', the 'rice cure', 'potato therapy' and even the use of opiates
1919	Frederick Allen (US diabetes specialist) published the 'total dietary regulation in the treatment of diabetes'. This treatment combined starvation diets with bed rest. Although Allen did have successful results in lowering blood glucose levels and it may have prolonged life for some diabetic patients, especially in type 2 diabetes, many still died of ketoacidosis or infections sustained through malnutrition. He later became the director of diabetes research in the Rockefeller Institute
1920s	RD Lawrence advocated the use of high-fat low-carbohydrate diets
1921	The discovery and isolation of insulin radically reduced death rates in type 1 diabetes, but survival brought with it other problems in the form of micro- and macrovascular disease
1940s	A link was made between diabetes and long-term complications (eye and kidney)
1940–55	Oral medications were developed to help lower blood glucose levels
1959	Two major types of diabetes were recognised, 'type 1' (insulin-dependent diabetes) and 'type 2' (non-insulin-dependent diabetes)
1970	Blood glucose meters and insulin pumps were developed
1993	The findings of the Diabetes Control and Complications Trial were published and clearly demonstrated that intensive therapy and tight metabolic control delay the onset and progression of long-term complications in type 1 diabetes
1998	The findings of the UK Prospective Diabetes Study were published, which clearly identified the importance of good blood glucose control and good blood pressure control in the delay and prevention of the onset of complications of type 2 diabetes
2000	The Diabetes and Nutrition Study Group of the European Association for the Study of Diabetes (2000) published its recommendations for the nutritional management of patients with diabetes mellitus
2002	The American Diabetes Association (2002) published a position statement on evidence-based nutrition principles and recommendations for the treatment and prevention of diabetes and related complications
2003	The Nutrition Sub Committee of the Diabetes Care Advisory Committee of Diabetes UK (2003) published a paper on the implementation of nutritional advice for individuals with diabetes

liberalised the diet for many individuals with diabetes. An update of these recommendations 10 years later has reinforced the high-carbohydrate low-fat diet (Nutrition Sub Committee of the British Diabetic Association Professional Advisory Committee, 1992; Ha & Lean, 1998). These recommendations have since been superseded by recommendations from the European Association for the Study of Diabetes (Diabetes and Nutrition Study Group of the European Association for the Study of Diabetes, 2000) and the American Diabetes Association (2002). In 2003 Diabetes UK published a document entitled 'The implementation of nutritional advice for individuals with diabetes' (Nutrition Sub Committee of the Diabetes Care Advisory Committee of Diabetes UK, 2003). This consensus-based paper builds on the Diabetes and Nutrition Study Group of the European Association for

the Study of Diabetes (2000) and American Diabetes Association (2002) evidence-based reviews. The paper discusses the practical implementation of dietary advice for individuals with diabetes and describes the provision of services needed to support this approach (Franz *et al.* 1995). The emphasis of the paper is on the practical application of nutritional advice, with the recommendation that dietary advice should be tailored to individuals, relatives and carers, and should take into account other lifestyle factors.

Dietary components

The following is a summary of some of the key nutritional guidelines and additional topics discussed in this most recent review paper from Diabetes UK (Nutrition Sub

Table 2. Nutritional management of diabetes: summary of dietary advice

Diet component	EASD (2000)	ADA (2002)	Diabetes UK (2003)
CHO	40–60% total energy		40–60% total energy
Sucrose	<10% total energy	No restriction. Sucrose should be substituted for other CHO sources	10% total energy eaten in the context of a healthy diet
Fat	25–35% total energy		<35% energy intake
<i>cis</i> -MUFA	10–20% total energy		10–20% total energy
Saturated + <i>trans</i> -unsaturated fat	<10% total energy	<10% total energy, <7% total energy if dyslipidaemia	<10% total energy
<i>n</i> -6 PUFA	<10% total energy	<10% total energy	<10% total energy
<i>n</i> -3 PUFA	Oily fish once per week Olive, rapeseed or soyabean oil Nuts + some green vegetables	Two to three portions oily fish per week	Oily fish one to two times weekly Fish-oil supplements not recommended
CHO + MUFA	60–70% total energy	60–70% total energy	60–70% total energy
Cholesterol	<300 mg/d	<300 mg/d, <200 mg/d if dyslipidaemia	
Plant stanol + sterol		2 g/d	2 g/d
Protein	10–20% total energy 0.8 g/kg per d	10–20% total energy, 0.8 g/kg in overt nephropathy	≤1 g/kg May benefit from <1 g/kg with nephropathy
Antioxidants	Vitamins A, C and E + flavenoids Not in pharmacological quantities		Encourage foods naturally high in vitamins + antioxidants
Folate	Regular consumption of foods high in folate		
Alcohol		1 unit/d for women 2 units/d for men	
Ca		1000–1500 mg/d	
Na (table salt and NaCl)		2400 mg (100 mmol) or 6 g/d	<6 g/d

EASD, Diabetes and Nutrition Study Group of European Association for the Study of Diabetes; ADA, American Diabetes Association; CHO, carbohydrate.

Committee of the Diabetes Care Advisory Committee of Diabetes UK, 2003; see Table 2).

Carbohydrate. Greater flexibility in the percentage of energy derived from carbohydrate and MUFA, i.e. 60–70% of the total energy intake, is recommended. An overall liberalisation in the consumption of sucrose (10% of the total energy intake) is recommended, in line with healthy eating recommendations for the general population. There is emphasis on the importance of total carbohydrate intake for blood glucose control, and the consumption of low-glycaemic-index foods is actively promoted. Concentrated non-nutritive sweeteners may be useful for reducing energy or sucrose intake for weight reduction and for aiding the reduction of triacylglycerol levels.

Fat. Monounsaturated fats are now promoted as the main source of dietary fat, and an intake of 10–20% of the total energy intake is recommended, because of its lower susceptibility to lipid peroxidation and thus lower atherogenic potential (Garg, 1998). Total fat should be <35% of the total energy intake. Saturated fat and *trans*-unsaturated fat should be <10% of the total energy intake. *n*-3 PUFA are promoted, as potentially they may decrease the risk of CVD and help to reduce triacylglycerol levels. An intake of two portions of oily fish weekly is recommended, and fish-oil supplements are not generally recommended because of the possibility of excessive doses, high intakes of fat-soluble vitamins and the possible interaction with anticoagulant medications. *n*-6 PUFA should be limited to <10% of the total energy intake. Dietary cholesterol has

less effect on blood cholesterol than saturated fat, but overall cholesterol should be ≤300 mg/d. Plant stanols and sterols may reduce LDL-cholesterol by 10–15% if enough is consumed, i.e. 2 g/d.

Protein. An overall daily intake of 10–20% of the total energy intake is recommended and should be ≤1 g/kg body weight. There may be a benefit in restricting protein to 0.6–0.8 g/kg body weight in patients with type 1 diabetes with a reduced glomerular filtration rate (Scottish Intercollegiate Guidelines Network, 2001) or patients with diabetes who have increased microalbuminuria or overt nephropathy.

Fibre. No quantitative recommendations for fibre intake are made. Diets high in fruit, vegetables, beans, pulses, wholegrains and cereals should be encouraged. Soluble fibre (e.g. fruit, vegetables, pulses and oats) may improve glycaemic and lipid control whereas insoluble fibre (e.g. wholegrains, cereals, rice, pasta) has a minimal effect on lipids. Insoluble fibre is beneficial to gastrointestinal health and, by promoting a feeling of fullness and satiety, may be helpful in weight reduction.

Vitamins and antioxidants. Foods naturally high in vitamins and antioxidants should be encouraged. There is no evidence to support the use of vitamin supplements outside those of particular clinical need.

Table salt and sodium chloride. NaCl intake should be limited to 6 g/d. Reducing NaCl intake from 12 g/d to 6 g/d can improve systolic and diastolic blood pressure by 5 and 2–3 mmHg respectively. Table salt substitutes in which Na

is replaced by K or Mg may be useful in the absence of other clinical conditions.

An adequate intake of Ca (1000–1500 mg/d) and K should be encouraged.

Alcohol. The metabolic effects of alcohol are complex and are influenced by many variables. The recommendation of a maximum intake of 21 units/week for men and 14 units/week for women has not changed. Alcohol has the same potential cardio-protective effect with or without diabetes. It has been recommended that alcohol should be restricted in those trying to lose weight, as it is a concentrated source of energy. Sugar-free mixers and avoidance of sweet drinks is to be encouraged. For those on insulin and sulphonylureas, hypoglycaemia may occur ≤ 16 h after taking alcohol.

Weight management in diabetes

Central obesity is associated with insulin resistance and increased cardiovascular risk (Campbell & Rossner, 2001). A waist circumference of >1020 mm in men and >880 mm in women predicts risks of comorbidities (Anonymous, 1998). It is encouraged that waist circumference along with BMI measurements should be used in nutritional assessment of individuals with diabetes. An initial moderate weight loss of 5–10% body weight for overweight individuals should be targeted, as this level of weight loss markedly reduces insulin resistance, improves blood glucose, improves lipid and blood pressure levels, and increases life expectancy. A patient with diabetes with a BMI of >35 kg/m² has a 10-fold increased risk of premature death (UK Prospective Diabetes Study Group, 1998). Combined treatment with insulin and metformin, which can reduce insulin dosage by reducing insulin resistance, may be useful for those who are overweight (McNulty *et al.* 2003).

Exercise

Individuals with diabetes should be encouraged to take regular physical exercise (Grylls *et al.* 2003). Exercise improves cardiovascular fitness and reduces insulin resistance (Boule *et al.* 2001). The emphasis of these recommendations is on increasing physical activity as well as planned exercise. When patients with diabetes are initiating or recommencing physical activity or exercise regimens, those at risk of hypoglycaemia should be given appropriate advice on how to manage blood glucose levels. This advice should include avoidance of exercise if blood glucose concentration is >15 mmol/l or there is ketonuria. Additionally, advice on appropriate insulin adjustment and carbohydrate is essential to avoid hypoglycaemia during and after exercise. Ongoing support is vital to facilitate positive changes to eating habits and physical activity (Frost *et al.* 2003).

Additional topics covered in the Nutrition Sub Committee of the Diabetes Care Advisory Committee of Diabetes UK (2003) consensus-based paper include evidence of the effectiveness of advice provided by trained dietitians (Delahanty, 1998) and the need for expansion of dietetic services nationwide within the UK. The need for structured

diet and lifestyle education programmes addressing self-management, motivation and empowerment for individuals with diabetes is addressed (Care Interventions Team, 2001) and will also be discussed in the present review. Some recommendations are made for special groups and special situations within the umbrella of diabetes, but are beyond the scope of the present review.

Important changes from previous guidelines

Some of the most important changes from previous recommendations include the following: an increase in the consumption of sucrose in line with healthy eating guidance for the general population; more active promotion of carbohydrate foods with a low glycaemic index; monounsaturated fats now promoted as the fat of choice; greater flexibility in the percentage of energy derived from carbohydrate and monounsaturated fats. In addition, there is emphasis on the usefulness of waist measurements along with BMI measurements in clinical assessment. The importance of the delivery of dietary advice is dealt with directly, as is the provision of facilities to address behaviour changes in the context of food choices and wider lifestyle changes.

Prescriptive education: is this adequate for individuals with diabetes?

The need for structured educational programmes to address self-management, motivation, empowerment and behaviour change has been identified as a requirement for individuals with diabetes (Delahanty, 1998; Muhlhauser & Berger, 2002). Is traditional prescriptive education adequate for individuals with diabetes? The epidemic of type 2 diabetes is projected to reach 333×10^6 cases worldwide by 2025. In the past 10 years the Diabetes Control and Complications Trial (The Diabetes Control and Complications Trial Research Group, 1993) and the UK Prospective Diabetes Study (for overview of results, see <http://www.dtu.ox.ac.uk/index.html?maindoc=ukpds/>) have shown that tight control of diabetes reduces the risks of complications in type 1 and type 2 respectively. As a result of these studies patients have been set demanding targets (Scottish Intercollegiate Guidelines Network, 2001) without adequate support to achieve them. Intensive modification to diet and lifestyle needs structured education and support to facilitate a change in behaviour. Traditional education may have been prescriptive, involving the provision of large amounts of information and advice with a strong recommendation of compliance. This form of advice has often invited negative patient response, with little success in achieving a change in diet and lifestyle behaviour.

Research has shown that the provision of diet and lifestyle information to patients with diabetes is not enough to facilitate behaviour change. Several studies have shown that structured education programmes designed to bring about diet and lifestyle changes and delay the onset and progression of micro- and macrovascular complications of diabetes are more successful (Pan *et al.* 1997; Tuomilehto *et al.* 2001; Cavan & Craddock, 2004). The

rapidly-growing population of individuals with diabetes, as well as the shortfall of dietitians working in diabetes (Robson *et al.* 2001), means that more effective education and greater allocation of dietetic services is essential to slow the progression to diabetes and to slow the onset and progression of complications of diabetes. An example of such a programme is one that was developed and refined in Germany by Mulhauser & Berger (2002). Centres in other countries have adapted the German programme, e.g. DAFNE in the UK (DAFNE Study Group, 2002), and this approach has shown improvements in Hb A_{1c}, dietary freedom and quality of life. The principle of this programme is intensive structured education of a specific patient group in various aspects of diet and lifestyle, including adjustment of fast-acting insulin analogues in accordance with carbohydrate intake.

The US diabetes prevention programme (Diabetes Prevention Program Research Group, 2002) randomised 3234 subjects with impaired glucose tolerance to a placebo, Metformin or an intensive programme of diet and exercise. New cases of diabetes were shown to be reduced by 58% for the diet and exercise group compared with 31% for the patients randomised to Metformin. The lifestyle-modification group received intensive education and support, with care managers delivering a personal sixteen-lesson curriculum and a subsequent monthly follow-up to reinforce behaviour change. Prevention studies using trained educators to deliver intensive education have achieved equally encouraging results in Finland (Tuomilehto *et al.* 2001) and China (Pan *et al.* 1997).

It has been shown that lifestyle modifications are not sustained once education and support are withdrawn (DAFNE Study Group, 2002; Diabetes Prevention Programme Group, 2002; Cavan & Cradock, 2004). The message is clear. The onset of diabetes and the progression to complications of diabetes can be delayed by intensive education and support to facilitate lifestyle behaviour modification. However, ongoing intensive input is required to effect and maintain this change.

The UK National Service Framework for Diabetes (Department of Health, 2002) has recognised that the provision of information, education and psychological support that facilitates self-management is the cornerstone of diabetes care, and has set primary care groups the target of providing empowering education by March 2006. Considerable manpower and resources are required to set up and maintain educational programmes, but the cost per individual is small compared with that of treating the consequences of uncontrolled diabetes.

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