

Review of dietary recommendations for diabetes mellitus

Pratik Choudhary*

Northern General Hospital, Diabetes and Endocrine Centre, Sheffield S5 7AU, UK

Abstract

Previous nutritional guidelines for people with diabetes focused on carbohydrate-based meal planning. Updated guidelines from Europe and North America reflect a more flexible approach to nutritional intervention. New aspects of these most recent recommendations include: (1) increased emphasis on the role of trained dietitians for educating people with diabetes; (2) greater individualization of dietary choices based on cultural, regional and personal preferences; (3) more flexibility for choosing between carbohydrate and monounsaturated fat consumption, but with limitations on intake of polyunsaturated fats (<10% of total energy); (4) broadened allowance of sucrose in the diet (up to 10% of total energy); and (5) greater recognition of physical activity as an important means to control weight and enhance general health. Expert guidelines vary regarding preferential intake of carbohydrates with lower glycemic indices.

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1. What is new in medical nutrition therapy?

Although medical nutrition therapy (MNT) has always been an important aspect of care for people with diabetes mellitus, a specific “diabetic diet” no longer exists, and nutritional principles continue to evolve [1]. People with diabetes, like those in the general population, are now encouraged to eat a healthy, well-balanced diet that provides all the essential macro- and micronutrients in appropriate amounts. They are offered evidence-based recommendations that can be adopted in the context of personal living patterns and individual preferences. Diabetes MNT has

always focused on achieving blood glucose targets, but current MNT goals also address lipid and lipoprotein profiles, particularly because of the associated risk for cardiovascular complications in patients with diabetes.

The major change in thinking about MNT has been a change of focus between fats and carbohydrates. Fats are no longer labelled “bad” and carbohydrates considered “good”, but both of these macronutrients are now recognized as having “good” and “bad” types. Since carbohydrates typically form the major portion of most meals, carbohydrates with a low glycemic index may be more suitable for people with diabetes [2,3]. This topic, however, continues to arouse considerable debate [4,5]. Sugar is no longer forbidden, but is counted as part of the total

* Tel.: +44 114 2174670; fax: +44 114 2424985.

E-mail address: p.choudhary@sheffield.ac.uk.

carbohydrate intake. Food choices appropriate to weight management are now considered essential, especially when weight loss is a therapeutic goal—often the case for people with type 2 diabetes. The total quantity of food consumed is as much responsible for the obesity epidemic as the type of food. Exercise is increasingly recognized as a vital complement to medical nutrition therapy, regardless of whether patients are managed by insulin, oral anti-diabetic medications, or diet alone.

2. Current goals of medical nutrition therapy for people with diabetes

Professional guidelines and recommendations for medical nutrition therapy (MNT) in diabetes have been developed in the UK and Europe, and in the USA and Canada [2,4–7]. While the guidelines for nutritional management differ slightly in content details, the underlying goals are similar. All recommendations seek to:

- sustain or improve health and quality of life through healthy food choices;
- establish and maintain blood glucose as near to normal as possible, thus averting the harmful consequences of hypo- or hyperglycemia; and

- address specific nutritional needs of individuals, while also taking into account personal preferences, cultural considerations, and lifestyle.

3. Updated nutritional recommendations

3.1. Overview of dietary composition

The current recommendations of the European Association for Study of Diabetes (EASD) and the American Diabetes Association (ADA) are summarized in Table 1 [4,5]. At present, the European and American guidelines are quite similar, and British recommendations are comparable [2]. The guidelines advise an intake of 60–70% of daily energy from carbohydrates and monounsaturated fats. This advice allows greater flexibility to accommodate individual dietary preferences. Sucrose (sugar) and sugar-containing foods are allowed, but should be limited to less than 10% of energy intake, and only eaten in the context of a healthy diet. ADA and EASD guidelines suggest that saturated fats constitute less than 10% of total energy intake, and recommend further restriction to less than 7 or 8% for individuals with LDL cholesterol ≥ 100 mg/dL (2.59 mmol/L). Polyunsaturated fat intake should be about 10% of total intake according to the EASD and ADA guidelines. The guidelines

Table 1
Current dietary recommendations for people with diabetes

	EASD [5]	ADA [4]	Current UK intake [8]
Carbohydrate + MUFA ^a	60–70%	60–70%	48–49% CHO + 12% MUFA ^b
As sucrose	10%	10%	12–14% ^c
Fat	Total fat intake $\leq 35\%$		35–36% ^d
Saturated	< 8 –10%	< 7 –10%	13% ^e
Polyunsaturated	$< 10\%$	$\sim 10\%$	6% ^f
Protein	10–20%	15–20%	17% ^g
Fiber	$>$ Intake encouraged	Intake encouraged ^h	NA
Salt	< 6 g/day	< 6 g/day	NA

^a CHO, carbohydrate; MUFA, monounsaturated fatty acids.

^b Actual MUFA intake for males: 12.1% of total energy; for females: 11.5% of total energy [8].

^c Actual sucrose intake for males: 13.5% of total energy; for females: 11.9% of total energy [8].

^d Actual total fat intake for males: 35.8% of total energy; for females: 34.9% of total energy [8].

^e Actual saturated fat intake for males: 13.4% of total energy; for females: 13.2% of total energy [8].

^f Actual polyunsaturated fat intake for males: 6.4% of total energy; for females: 6.3% of total energy [8].

^g Actual protein intake for males: 16.5% of total energy; for females: 16.6% of total energy [8].

^h 50 g/day incurs benefits for reduction of hyperglycemia, hyperinsulinemia, and plasma lipids, but it is not yet clear whether this high amount of fiber is palatable and the gastrointestinal side-effects tolerable to most people.

recommend similar levels of protein, fiber and sodium intake (Table 1). Based on a British dietary analysis, the intake of saturated fat and sucrose is above levels recommended by either of the guidelines [8]. A favorable strategy is to replace excess saturated fats with monounsaturated fatty acids.

3.2. Carbohydrate

Common dietary carbohydrate includes sugars, starch, and fiber. Current guidelines suggest that 60–80% of energy intake be consumed as a combination of carbohydrate and monounsaturated fat [2,4,5,7]. Up to 10% can be consumed as sucrose or sucrose-containing foods, and should be counted in the total carbohydrate intake. Sucrose or sucrose-containing foods should be eaten sensibly by individuals who are concerned about weight loss [2,4,7]. Guidelines also encourage intake of fiber from fruits, vegetables, and whole grain cereals.

While carbohydrates are recognized to cause a postprandial rise in blood glucose, many factors contribute to the extent of the rise. These factors include the amount of carbohydrate consumed, the composition of this carbohydrate (constituent proportions of glucose, fructose, lactose, amylose, amylopectin, or starch), the effects of cooking or processing on food structure, and other components of the meal (such as fats that may slow digestion). However, some experts maintain that the amount of carbohydrate consumed has a greater glycemic influence than does the source (sugar or starch) or type (low or high glycemic index) of carbohydrate [1].

The glycemic response to various foods has been quantified as a “glycemic index” (GI), a concept that has aroused controversy among diabetes experts. To determine the GI, the rise in blood glucose after consuming a 50 g portion of the food is compared with that after 50 g of glucose or bread [9]. Low GI foods have been shown to decrease postprandial blood glucose rises, increase satiety and promote weight loss, improve insulin sensitivity, and enhance lipid profile [3,10,11]. The European, Canadian, and British nutritional guidelines for diabetes encourage the use of foods with low glycemic indices (for example, legumes, oats, pasta, and fresh fruits), while the American guidelines suggest there is not enough evidence of long-term benefit for this to be a primary strategy [2,4,5,7].

Despite short-term benefits of low GI foods for postprandial glucose control, some American experts maintain that long-term benefits of GI-based meal planning remain unproven and alternative nutritional strategies are more effective. A meta-analysis of 14 GI studies (including 356 diabetic patients) showed small but clinically useful benefits from choosing low-GI foods in preference to conventional or high-GI foods (HbA_{1c} reduction of 0.43% over an average of 10 weeks) [12]. Although many of the studies included only small numbers of subjects and were of short duration, low-GI foods were of benefit to people with either type 1 or 2 diabetes (−0.4 and −0.2% HbA_{1c} change, respectively) [12]. On the other hand, Franz has claimed that other nutritional strategies are more effective [13]. For example, HbA_{1c} levels were decreased by ~1–2% units when type 1 diabetes patients were trained to count mealtime carbohydrates and adjust their mealtime insulin doses accordingly [14,15]. Other approaches similarly yielded a lowering of HbA_{1c} by up to 2% (from 9 to 7%) for patients with type 2 diabetes receiving intensive nutritional intervention for three months in the UKPDS; changes were mostly attributed to lower energy intake [16].

3.3. Protein

Protein is an important nutritional component that is variously affected by the diabetic condition. In the UK and the USA, protein accounts for 10–15% of the average adult energy intake, an intake that is similar across age groups and for people with or without diabetes [2,9]. Studies both in diabetic and non-diabetic individuals have shown that ingested protein does not contribute to postprandial glucose concentration; however, in individuals capable of producing insulin, protein plays a role in promoting its secretion [9].

Although expressed differently, recommendations for protein intake for people with diabetes are similar in all professional guidelines [2,4,5,7]. British guidelines advocate a daily intake of no more than 1 g protein/kg body weight, while the Canadian guidelines recommend about 0.86 g/kg per day [2,17]. American and Canadian guidelines recommend sourcing 15–20% of total daily energy from protein (providing renal function is normal), while European

guidelines suggest 10–20% [4,5,7]. European guidelines advise protein intake at the low end of the range (about 0.8 g/kg body weight) for diabetic patients with evidence of nephropathy, with a minimum daily intake of 0.6 g/kg body weight because of risk for malnutrition at lower levels [5]. American guidelines advise that a protein intake greater than 20% of energy should be avoided because of the potential risk of the development of nephropathy and advise caution about the potential adverse effects of high protein/low carbohydrate diets on plasma LDL cholesterol [4].

3.4. Fatty acids and dietary cholesterol

Clinical studies show that high-fat diets impair glucose tolerance and promote obesity, dyslipidemia, and atherosclerosis; however, these metabolic abnormalities can be improved or reversed by reducing the intake of saturated fat [17]. The primary dietary fat goal for people with diabetes is thus to limit dietary intake of saturated fat and cholesterol. To do so, current guidelines in North America and Europe recommend that saturated fats should provide <10% of daily energy requirements, or even lower (6%) in individuals with other cardiovascular risk factors (e.g. LDL-cholesterol ≥ 100 mg/dL or ≥ 2.59 mmol/L). [2,4,5,7] Specifically, processed foods containing saturated fats and trans-polyunsaturated fatty acids should be limited. Intake of polyunsaturated fatty acids is also limited to <10% of total energy, although n-3 polyunsaturated fatty acids (as in oily fish such as salmon) may be cardioprotective [4,7].

On the other hand, monounsaturated fatty acids (MUFA) can have a beneficial effect on lipid profiles by increasing plasma HDL-cholesterol. Together with carbohydrates, MUFAs should contribute 60–70% of total energy intake [2,4,5]. Canadian guidelines limit fat intake to $\leq 30\%$ of daily energy requirements [7].

Saturated fats can be replaced by either carbohydrate or by monounsaturated fats, with the choice determined by personal preferences and weight management goals. Monounsaturated fats (e.g. canola, olive, and peanut oils) are recognized to be an important source of dietary fat because of their lower susceptibility to lipid peroxidation and consequent lower atherogenic potential [18]. Although it was thought that an ad libitum diet rich in energy-dense

fats could potentially lead to weight gain, some studies have shown it is possible to achieve weight loss and improve lipid profile using a diet incorporating a high proportion of MUFAs [19–21]. Increased carbohydrate consumption can reduce total and LDL-cholesterol, but may also decrease HDL-cholesterol and increase triglycerides. These negative impacts on lipid profile can be attenuated by exercise [4].

Current recommendations on cholesterol intake for the general population also apply to people with diabetes [22]. Cholesterol intake should be lower than 300 mg/day. Individuals with elevated LDL-cholesterol may benefit from lowering cholesterol intake below 200 mg/day.

3.5. Vitamins and micronutrients

People with diabetes should be encouraged to consume adequate amounts of vitamins and minerals from natural food sources, particularly fruits, nuts, and vegetables [2,4,5,7]. Foods rich in antioxidants (tocopherols, carotenoids, Vitamin C, and flavonoids) and other water and fat-soluble vitamins are especially encouraged. Consumption of foods rich in folate (e.g. citrus fruits and legumes) will ensure adequate folate status, and possibly reduce risk of coronary heart disease, while diets that include oily fish (e.g. salmon, tuna) and whole grain breads or cereals provide fat- and water-soluble vitamins [5].

Supplementation with a multivitamin preparation is recommended for selected patients with diabetes (e.g. the elderly, pregnant or lactating women, strict vegetarians, and individuals on calorie-restricted diets) who may be at particular risk of micronutrient deficiency [4]. There are some claims that chromium and vanadium supplementation may improve glycaemic control, but there is still insufficient evidence to support such claims, and megadose supplementation may actually be unsafe [4,17].

3.6. Fiber

Guidelines from North America and Europe encourage fiber intake from sources such as grains, fruits, and vegetables, although quantities are not specified [2,4,5,7]. Soluble fiber is reported to promote lowering of plasma glucose and lipids, while insoluble fiber can support weight loss through its ability to confer satiety

[2]. It is advised that fiber be taken along with meals to have the maximum benefit.

3.7. Diabetic or dietetic foods

Foods containing fructose, sugar alcohols, and other nutritive sweeteners are sometimes marketed as “diabetic foods”. Professional guidelines do not recommend any of these foods, as no clinical advantages of the use of these products have been documented. Indeed, some products which contain sugar alcohols such as xylitol, mannitol, or sorbitol may have adverse effects such as the tendency to induce diarrhea. Fructose produces smaller rises in postprandial glucose levels than do other carbohydrates, and at moderate intakes, is considered appropriate for use in diabetes [23,24]. Large amounts of fructose, however, may have an adverse effect on plasma lipids [25].

Non-nutritive sweeteners—saccharin, aspartame, acesulfame potassium, and sucralose—have proven to be safe substitutes for sucrose when caloric restriction is appropriate and is approved for use by individuals with diabetes by professional guidelines [2,4,5,7]. In the new Canadian guidelines, use of saccharin and cyclamates is not recommended during pregnancy and lactation [7].

3.8. Alcohol

Nutritional guidelines concur that most people with diabetes can safely consume alcohol, although certain precautions should be followed [2,4,5]. To reduce the risk of hypoglycemia, individuals with diabetes are advised to consume food when drinking alcoholic beverages.

While moderate consumption may afford modest cardiovascular benefits, heavy or excessive alcohol consumption is a leading cause of avoidable death in many countries. For individuals who choose to drink alcoholic beverages, only limited daily intake is recommended. American and European guidelines limit consumption to one drink per day (12 ounces beer, 5 ounces wine, or 1.5 ounces of distilled spirits) for adult women and two drinks per day for adult men. UK guidelines are similar, allowing 14 alcohol units per week for women and 21 alcohol units per week for men (2 units equal to 50 mL liquor, 175 mL wine, or 568 mL beer) with 1–2 alcohol-free days [2,4,5].

3.9. Implementation of nutritional and lifestyle advice

All guidelines recommend having a dietitian-educator work with every patient in order to apply formal nutritional objectives in a way that is realistic and practical for each individual [2,4,5,7]. The dietitian’s role is to facilitate changes in diet, rather than to strictly define foods and activities that are “good” and “bad”.

The necessary nutritional changes vary in keeping with the patient’s age, medications, usual habits and preferences, risk factors, level of physical fitness, and the patient’s motivation to make changes. Specific nutritional recommendations also differ according to whether the patient has type 1 or 2 diabetes mellitus. In type 1 diabetes, the strategy focuses on trying to match the insulin requirement to the carbohydrate content of the meal and on avoiding hypoglycemia. In this group, the implementation of frequent small snacks will depend on the insulin regimen. In patients with type 2 diabetes, there is more emphasis on total caloric intake and a greater emphasis on restriction of saturated fat, as patients in this group have a much higher cardiovascular risk than patients with type 1 diabetes.

4. Summary

Guidelines from across the world recognize that every patient with diabetes should have an individualized nutritional plan developed with the help and support of a qualified dietitian. Principles of healthy eating should be followed by all individuals, and specific considerations are recommended for people with diabetes (Table 2). The major part of the diet should be composed of carbohydrate and monounsaturated fats, with a limited amount of sucrose being permitted. Patients with type 2 diabetes in particular often need to agree to and follow a diet plan designed to maintain or reduce their body weight. In the future, patients could benefit from the development of separate and targeted guidelines for types 1 and 2 diabetes. Many experts would also like to see greater emphasis on weight reduction and intake of foods with low glycemic indices.

Table 2

Highlighted nutritional principles for people with diabetes

General

- Eat a variety of foods
- Emphasize cereals or breads containing whole grains, as well as fruits and vegetables
- Achieve and maintain a healthy body weight through physical activity and healthy eating practices
- Limit sodium

Carbohydrate (together with MUFA, 60–80% of daily energy)^a

- Include fiber-rich foods such as grains, fruits, and vegetables
- Sucrose intake up to 10% of daily energy is permitted
- Use of saccharin, aspartame, acesulfame potassium, cyclamates, and sucralose is acceptable^b

Protein (15–20% of daily energy)

- Evidence does not show that usual protein intake should be modified because of diabetes

Fat (MUFA + carbohydrates comprise 60–80% of daily energy)

- Restrict combined saturated fats and trans fatty acids to <10% of daily energy intake
- Consume MUFA preferentially over saturated fats
- Include foods rich in polyunsaturated omega-3 fatty acids

Vitamin and mineral supplements

- Routine supplementation is not necessary, but can be considered in specific subpopulations (e.g. elderly individuals, pregnant women, strict vegetarians)

Alcohol

- Limit intake (two drinks/day for men and one drink/day for women)

^a MUFA, monounsaturated fatty acids.^b Women who are pregnant or lactating are advised to avoid cyclamates and saccharin.

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