

Nutrition Recommendations and Principles for People With Diabetes Mellitus

AMERICAN DIABETES ASSOCIATION

Medical nutrition therapy (MNT) is integral to total diabetes care and management. Although adherence to nutrition and meal planning principles is one of the most challenging aspects of diabetes care, nutrition therapy is an essential component of successful diabetes management.

Achieving nutrition-related goals requires a coordinated team effort that includes the person with diabetes. Because of the complexity of nutrition issues, it is recommended that a registered dietitian, knowledgeable and skilled in implementing diabetes MNT, be the team member providing nutrition care and education.

Effective nutrition self-management training requires an individualized approach appropriate for the personal lifestyle and diabetes management goals of the individual with diabetes. Monitoring of glucose and glycated hemoglobin, lipids, blood pressure, and renal status is essential to evaluate nutrition-related outcomes. If goals are not met, changes must be made in the overall diabetes care and management plan.

A nutrition assessment is used to determine the nutrition prescription, which is based on treatment goals, and what the individual with diabetes is able and willing to do. To facilitate adherence, sensitivity to cultural, ethnic, and financial considerations is of prime importance.

This paper reflects current scientific nutrition and diabetes knowledge. However, there are limited published data for some recommendations and, under these circumstances, recommendations are based on clinical experiences and consensus. This

position statement is based on a technical review (1), which discusses published research and issues that remain unresolved. For information on incorporating these nutrition recommendations into health care facilities, see the American Diabetes Association position statement "Translation of the Diabetes Nutrition Recommendations for Health Care Institutions" (2).

GOALS OF MEDICAL NUTRITION THERAPY

— Although the overall goal of MNT is to assist individuals with diabetes in making changes in nutrition and exercise habits leading to improved metabolic control, there are additional specific goals:

1. Maintenance of as near-normal blood glucose levels as possible by balancing food intake with insulin (either endogenous or exogenous) or oral glucose-lowering medications and physical activity levels.
2. Achievement of optimal serum lipid levels.
3. Provision of adequate calories for maintaining or attaining reasonable weights for adults, normal growth and development rates in children and adolescents, increased metabolic needs during pregnancy and lactation, or recovery from catabolic illnesses. Reasonable weight is defined as the weight an individual and health care provider acknowledge as achievable and maintainable, both short- and long-term. This may not be the same as the traditionally defined desirable or ideal body weight.

4. Prevention and treatment of the acute complications of insulin-treated diabetes such as hypoglycemia, short-term illnesses, and exercise-related problems, and of the long-term complications of diabetes such as renal disease, autonomic neuropathy, hypertension, and cardiovascular disease (CVD).
5. Improvement of overall health through optimal nutrition. *Dietary Guidelines for Americans* (3) and the *Food Guide Pyramid* (4) summarize nutrient needs and nutritional guidelines for all healthy Americans. The *Diabetes Food Guide Pyramid* (5) is more specific for individuals with diabetes. However, all three provide guidelines that can be used by people with diabetes and their family members to make healthful food choices.

NUTRITION THERAPY AND TYPE 1 DIABETES

— A meal plan based on the individual's usual food intake should be determined and used as the basis for integrating insulin therapy into the usual eating and exercise patterns. It is recommended that individuals using insulin therapy eat at consistent times synchronized with the time-action of the insulin preparation used. Further, individuals need to monitor blood glucose levels and adjust insulin doses for the amount of food usually eaten. Intensified therapy, including multiple daily injections, continuous subcutaneous insulin infusion (CSII) using an insulin pump, and rapid-acting insulin, allows for more flexibility in the timing of meals and snacks, as well as in the amount of food eaten. Individuals on intensified insulin regimens can make adjustments in rapid- or short-acting insulin to cover the carbohydrate content of their meals and, possibly, snacks and for deviations from usual eating and exercise habits.

NUTRITION THERAPY AND TYPE 2 DIABETES

— Primary MNT goals for individuals with type 2 diabetes are to achieve and maintain glucose, lipid,

Originally approved October 1986. Revised 1994, 1996, and 1997.

The recommendations in this paper are based on the evidence reviewed in the following publications: Nutrition principles for the management of diabetes and related complications (Technical Review). *Diabetes Care* 17:490-518, 1994; Protein content of the diabetic diet (Technical Review). *Diabetes Care* 17:1502-1513, 1994; Selected vitamins and minerals in diabetes (Technical Review). *Diabetes Care* 17:464-479, 1994; and Prevention and treatment of obesity: application to type 2 diabetes (Technical Review). *Diabetes Care* 20:1744-1766, 1997.

Abbreviations: ADI, acceptable daily intake; CSII, continuous subcutaneous insulin infusion; CVD, cardiovascular disease; FDA, Food and Drug Administration; GFR, glomerular filtration rate; MNT, medical nutrition therapy; NCEP, National Cholesterol Education Program.

and blood pressure goals. Hypocaloric diets and weight loss usually improve short-term glycemic levels and have the potential to improve long-term metabolic control. However, traditional dietary strategies, and even very-low-calorie diets, have usually not been effective in achieving long-term weight loss. As research continues to elucidate why weight loss and maintenance is difficult for many people, the emphasis for individuals with type 2 diabetes needs to expand beyond weight loss to achieving and maintaining near-normal blood glucose levels. Several additional strategies can be implemented; however, there is no one proven strategy or method that can be uniformly recommended.

A moderate caloric restriction (250–500 calories less than average daily intake as calculated from a food history) and a nutritionally adequate meal plan with a reduction of total fat, especially saturated fat, accompanied by an increase in physical activity should be recommended. A hypocaloric diet (independent of weight loss) is associated with increased sensitivity to insulin and improvement in blood glucose levels. Moderate weight loss (5–9 kg [10–20 lb]), irrespective of starting weight, has been shown to reduce hyperglycemia, dyslipidemia, and hypertension.

Spacing of meals (spreading nutrient intake, particularly carbohydrate, throughout the day) is another strategy that can be adopted. Regular exercise and learning new behaviors and attitudes can help facilitate long-term lifestyle changes. However, if individuals with diabetes have made all the lifestyle changes they are able to make and metabolic control has not improved, an oral glucose-lowering agent and/or insulin may need to be added to MNT.

Many individuals with refractory obesity may have limited success with the above strategies. As new pharmacological agents (for people with BMI ≥ 27 kg/m² with other health risks or problems, e.g., diabetes, or >30 kg/m² without other health risks or problems) become available, they may prove to be effective. Gastric reduction surgery is available for people with a BMI >35 kg/m². Studies on the long-term efficacy and safety of these methods are, however, needed.

PROTEIN — There are limited scientific data upon which to establish firm nutritional recommendations for protein intake for individuals with diabetes. At the

present time, there is insufficient evidence to support protein intakes either higher or lower than average protein intake for the general population. For people with diabetes, this translates into ~10–20% of daily caloric intake from protein. Dietary protein can be derived from both animal and vegetable sources.

With the onset of overt nephropathy, lower intakes of protein should be considered. Several small studies in humans with diabetic nephropathy have shown that a prescribed protein-restricted diet of 0.6 g · kg⁻¹ · day⁻¹ (subjects actually only achieved a restriction of 0.7 g · kg⁻¹ · day⁻¹) retards the rate of fall of glomerular filtration rate (GFR) modestly. However, the recent Modified Diet in Renal Disease Study, in which only 3% of the patients had type 2 diabetes and none had type 1 diabetes, failed to show a clear benefit of protein restriction (6).

At this point in time, the general consensus is to prescribe a protein intake of approximately the adult Recommended Dietary Allowance (RDA) of 0.8 g · kg⁻¹ · day⁻¹ (~10% of daily calories) in the patient with overt nephropathy. However, it has been suggested that once the GFR begins to fall, further restriction to 0.6 g · kg⁻¹ · day⁻¹ may prove useful in slowing the decline of GFR in selected patients. On the other hand, nutrition deficiency may occur in some individuals and may be associated with muscle weakness.

Protein-restricted meal plans should be designed by a registered dietitian familiar with all components of MNT for diabetes. For information on nephropathy, see the American Diabetes Association position statement “Diabetic Nephropathy” (7).

TOTAL FAT — If dietary protein contributes 10–20% of the total caloric content of the diet, then 80–90% of calories remain to be distributed between dietary fat and carbohydrate. Less than 10% of these calories should be from saturated fats and $\leq 10\%$ of calories from polyunsaturated fats, leaving 60–70% of the total calories from monounsaturated fats and carbohydrates. The distribution of calories from fat and carbohydrate can vary and can be individualized based on the nutrition assessment and treatment goals.

The recommended percentage of calories from fat is dependent on identified lipid problems and treatment goals for glucose, lipids, and weight. People who are at a healthy weight and have normal lipid lev-

els are encouraged to follow the recommendations of the National Cholesterol Education Program (NCEP) (8,9). The NCEP recommends that all individuals over 2 years limit fat intake to $<30\%$ of total calories with saturated fat restricted to $<10\%$ of total calories. Polyunsaturated fat intake should be $<10\%$ of calories with monounsaturated fat in the range of 10–15% of calories. If LDL cholesterol is the primary concern, or if levels are elevated, further reduction of saturated fat to 7% of total calories and dietary cholesterol to <200 mg/day (NCEP Step II diet) is recommended. Polyunsaturated fats of the omega-3 series are provided naturally in fish and other seafood, and the intake of these foods need not be curtailed in people with diabetes.

If obesity and weight loss are the primary concerns, a reduction in dietary fat should be considered. Although foods with fat replacers have the potential to help people with diabetes reduce total fat and saturated fat intake, individuals must learn how to incorporate these foods into their food/meal plan. Additional research is needed to assess the impact of fat replacers on the total fat and caloric content of the diet. For more information on fat replacers, see the American Diabetes Association position statement “Role of Fat Replacers in Diabetes Medical Nutrition Therapy” (10).

If triglycerides and very-low-density lipoprotein cholesterol are the primary concerns, one approach that may be tried is a moderate increase in monounsaturated fat intake with $<10\%$ of the calories from saturated fats and a more moderate carbohydrate intake. However, in obese individuals, care should be taken to ensure that increased fat does not perpetuate or aggravate the obesity. In addition, individuals with triglyceride levels $\geq 1,000$ mg/dl (≥ 11.3 mmol/l) require reduction of all types of dietary fat ($<10\%$ of calories) in addition to pharmacologic treatment to reduce the risk of pancreatitis.

Monitoring of glycemic and lipid status and body weight, with any dietary fat modifications, is essential to assess the effectiveness of the nutrition recommendations.

SATURATED FAT AND CHOLESTEROL

— A reduction in saturated fat and cholesterol consumption is an important goal to reduce the risk of CVD. Diabetes is a strong independent

risk factor for CVD, over and above the adverse effects of an elevated serum cholesterol. Therefore, <10% of the daily calories should be from saturated fats, and dietary cholesterol should be limited to ≤ 300 mg daily. However, even these recommendations must be incorporated with consideration of an individual's cultural and ethnic background.

CARBOHYDRATE AND SWEETENERS

— The percent of calories from carbohydrate will also vary and is individualized based on the individual's eating habits and glucose and lipid goals. For most of this century, the most widely held belief about the nutritional treatment of diabetes has been that simple sugars should be avoided and replaced with starches. This belief appears to be based on the assumption that sugars are more rapidly digested and absorbed than are starches and thereby aggravate hyperglycemia to a greater degree. There is, however, very little scientific evidence that supports this assumption. Fruits and milk have been shown to have a lower glycemic response than most starches, and sucrose produces a glycemic response similar to that of bread, rice, and potatoes. Although various starches do have different glycemic responses, from a clinical perspective, first priority should be given to the total amount of carbohydrate consumed rather than the source of the carbohydrate.

Sucrose

Scientific evidence has shown that the use of sucrose as part of the total carbohydrate content of the diet does not impair blood glucose control in individuals with type 1 or type 2 diabetes. Sucrose and sucrose-containing foods must be substituted for other carbohydrates gram for gram and not simply added to the meal plan. In making such substitutions, the nutrient content of concentrated sweets and sucrose-containing foods, as well as the presence of other nutrients frequently ingested with sucrose, such as fat, must be considered.

Fructose

Dietary fructose produces a smaller rise in plasma glucose than isocaloric amounts of sucrose and most starches. In that regard, fructose may offer an advantage as a sweetening agent in the diabetic diet. However, because of the potential adverse effects of large amounts of fructose (i.e., double the usual intake [20% of calories]) on serum

cholesterol and LDL cholesterol, fructose may have no overall advantage as a sweetening agent in the diabetic diet. Although people with dyslipidemia should avoid consuming large amounts of fructose, there is no reason to recommend that people with diabetes avoid consumption of fruits and vegetables, in which fructose occurs naturally, or moderate consumption of fructose-sweetened foods.

Other nutritive sweeteners

Nutritive sweeteners other than sucrose and fructose include corn sweeteners, such as corn syrup, fruit juice or fruit juice concentrate, honey, molasses, dextrose, and maltose. There is no evidence that foods sweetened with these sweeteners have any significant advantage or disadvantage over foods sweetened with sucrose in decreasing total calories or carbohydrate content of the diet or in improving overall diabetes control.

Sorbitol, mannitol, and xylitol are common sugar alcohols (polyols) that produce a lower glycemic response than sucrose and other carbohydrates. Starch hydrolysates are formed by the partial hydrolysis and hydrogenation of edible starches, thus becoming polyols. Although the exact caloric value of sugar alcohols vary, they average ~ 2 kcal/g compared with the 4 kcal/g from other carbohydrates. Evidence is limited to suggest that this can be expected to contribute to a major reduction in total calories or in the total carbohydrate content of the daily diet. Furthermore, excessive amounts of polyols may have a laxative effect.

The calories and carbohydrate content from all nutritive sweeteners must be accounted for in the meal plan and have the potential to affect blood glucose levels.

Nonnutritive sweeteners

Saccharin, aspartame, and acesulfame K are approved for use in the U.S. by the Food and Drug Administration (FDA). For all food additives, including nonnutritive sweeteners, the FDA determines an acceptable daily intake (ADI), which is defined as the amount of a food additive that can be safely consumed on a daily basis over a person's lifetime without any adverse effects and includes a 100-fold safety factor. Actual intake by individuals with diabetes for all nonnutritive sweeteners is well below the ADI.

FIBER — Dietary fiber may be helpful in the treatment or prevention of constipation

and several gastrointestinal disorders, including colon cancer, and provides satiety value to the diet, and large amounts of soluble fiber have a beneficial effect on serum lipids. People with diabetes would be as amenable to these effects as those without diabetes. Although selected soluble fibers are capable of inhibiting absorption of glucose from the small intestine, in the amounts likely to be consumed from foods, the clinical significance of this effect on blood glucose levels is probably insignificant. Therefore, recommendations for people with diabetes are the same as for the general population related to fiber and a healthful diet. Daily consumption of a diet containing 20–35 g dietary fiber from both soluble and insoluble fibers from a wide variety of food sources is recommended.

SODIUM

— People differ in their sensitivity to sodium and its effect on blood pressure. Because it is impractical to assess individual sodium sensitivity, intake recommendations for people with diabetes are the same as for the general population. Some health authorities recommend no more than 3,000 mg/day of sodium for the general population, while other authorities recommend no more than 2,400 mg/day. For people with mild to moderate hypertension, $\leq 2,400$ mg/day of sodium is recommended. For people with hypertension and nephropathy, $\leq 2,000$ mg/day of sodium is recommended.

ALCOHOL

— The same precautions regarding the use of alcohol that apply to the general public also apply to people with diabetes. *Dietary Guidelines for Americans* (2) recommends no more than two drinks per day for men and no more than one drink per day for women.

The effect of alcohol on blood glucose levels is dependent not only on the amount of alcohol ingested but also on the relationship to food intake. Alcohol is not metabolized to glucose and inhibits gluconeogenesis; therefore, if alcohol is consumed without food by people treated with insulin or oral glucose-lowering agents, hypoglycemia can result. Hypoglycemia can occur at blood alcohol levels which do not exceed mild intoxication.

If used in moderation and with food, however, blood glucose levels are not affected by the ingestion of alcohol when diabetes is well controlled. For individuals using insulin, two or less alcoholic beverages

Table 1—Historical perspective of nutrition recommendations

Year	Distribution of calories (%)		
	Carbohydrate	Protein	Fat
Before 1921		Starvation diets	
1921	20	10	70
1950	40	20	40
1971	45	20	35
1986	≤60	12–20	<30
1994	*	10–20	*+

*Based on nutritional assessment and treatment goals. †Less than 10% of calories from saturated fats.

ages (1 alcoholic beverage = 12 oz beer, 5 oz wine, or 1 1/2 oz distilled spirits) can be ingested with and in addition to the regular meal plan. No food should be omitted because of the possibility of alcohol-induced hypoglycemia. When calories from alcohol need to be calculated as part of the total caloric intake, alcohol is best substituted for fat exchanges (1 alcoholic beverage = 2 fat exchanges) or fat calories.

Abstinence from alcohol should be advised for people with a history of alcohol abuse or during pregnancy. Reduction of or abstinence from alcohol intake is advisable for diabetic individuals with other medical problems such as pancreatitis, dyslipidemia, especially elevated triglycerides, or neuropathy.

MICRONUTRIENTS: VITAMINS AND MINERALS

When dietary intake is adequate, there is generally no need for additional vitamin and mineral supplementation for the majority of people with diabetes. Although there are theoretical reasons to supplement with antioxidants, there is little confirmatory evidence at present that such therapy has any benefits.

The only known circumstance in which chromium replacement has any beneficial effect on glycemic control is for people who are chromium deficient as a result of long-term chromium-deficient parenteral nutrition. However, it appears that most people with diabetes are not chromium deficient, and, therefore, chromium supplementation has no known benefit.

Similarly, although magnesium deficiency may play a role in insulin resistance, carbohydrate intolerance, and hypertension, the available data suggest that routine

evaluation of serum magnesium levels is recommended only in patients at high risk for magnesium deficiency. Levels of magnesium should be repleted only if hypomagnesium can be demonstrated.

Potassium loss may be sufficient to warrant dietary supplementation in patients taking diuretics. Hyperkalemia sufficient to warrant dietary potassium restriction may occur in patients with renal insufficiency or hyporeninemic hypoaldosteronism or in patients taking angiotensin-converting enzyme inhibitors.

PREGNANCY— Nutrition recommendations for women with preexisting and gestational diabetes should be based on a nutrition assessment. Monitoring blood glucose levels, urine ketones, appetite, and weight gain can be a guide to developing and evaluating an appropriate individualized nutrition prescription and meal plan and to making adjustments to the meal plan throughout pregnancy to ensure desired outcomes.

SUMMARY— A historical perspective of nutrition recommendations is provided in Table 1. Today there is no one “diabetic” or “ADA” diet. The recommended diet can only be defined as a nutrition prescription based on assessment and treatment goals and outcomes.

MNT for people with diabetes should be individualized, with consideration given to usual eating habits and other lifestyle factors. Nutrition recommendations are then developed and implemented to meet treatment goals and desired outcomes. Monitoring metabolic parameters, including blood glucose levels, glycated hemoglobin, lipids, blood pressure, body weight, and renal function, if appropriate,

as well as quality of life, is crucial to ensure successful outcomes. Furthermore, it is essential that ongoing nutrition self-management education and care be provided for individuals with diabetes.

References

1. Franz MJ, Horton ES, Bantle JP, Beebe CA, Brunzell JD, Coulston AM, Henry RR, Hoogwerf BJ, Stacpoole PW: Nutrition principles for the management of diabetes and related complications (Technical Review). *Diabetes Care* 17:490–518, 1994
2. American Diabetes Association: Translation of the diabetes nutrition recommendations for health care institutions (Position Statement). *Diabetes Care* 21 (Suppl. 1):S66–S68, 1998
3. U.S. Department of Agriculture, U.S. Department of Health and Human Services: *Nutrition and Your Health: Dietary Guidelines for Americans*. 4th ed. Hyattsville, MD, USDA's Human Nutrition Information Service, 1995
4. U.S. Department of Agriculture: *The Food Guide Pyramid*. Hyattsville, MD, USDA's Human Nutrition Information Service, 1992
5. American Diabetes Association and The American Dietetic Association: *The First Step in Diabetes Meal Planning*. Alexandria, VA, American Diabetes Association, 1995
6. Levey AS, Adler S, Caggiula AW, England BK, Greene T, Hunsicker LG, Kusek JW, Rogers NL, Teschan PE: Effects of dietary protein restriction on the progression of advanced renal disease in the Modification of Diet in Renal Disease Study. *Am J Kidney Dis* 27:652–663, 1996
7. American Diabetes Association: Diabetic nephropathy (Position Statement). *Diabetes Care* 21 (Suppl. 1):S50–S53, 1998
8. Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults: Summary of the second report of the National Cholesterol Education Program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel II). *JAMA* 269:3015–3023, 1993
9. Expert Panel on Blood Cholesterol Levels in Children and Adolescents: Treatment recommendations of the National Cholesterol Education Program Report of the Expert Panel on Blood Cholesterol Levels in Children and Adolescents. *Pediatrics* 89 (Suppl.):525–584, 1992
10. American Diabetes Association: Role of fat replacers in diabetes medical nutrition therapy (Position Statement). *Diabetes Care* 21 (Suppl. 1):S64–S65, 1998