The 2006 American Diabetes Association Nutrition Recommendations and Interventions for the Prevention and Treatment of Diabetes

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The 2006 American Diabetes Association (ADA) nutrition recommendations reaffirm the importance of medical nutrition therapy (MNT) in the prevention of diabetes, treatment of existing diabetes, and prevention and treatment of the complications of diabetes in which MNT plays a role. The differences between the 2002 technical review and the 2006 position statement reflect research published after 2000. The recommendations continue to be graded according to the ADA evidence grading system.

MNT, as illustrated in Table 1, plays a vital role across the continuum of diabetes, and interventions change as the disease progresses. Primary prevention first seeks to reduce the prevalence of obesity and thus reduce the risk of developing pre-diabetes and diabetes. For individuals with pre-diabetes, MNT focuses on the prevention or delay of diabetes by moderate weight loss and increased physical activity. However, when overt diabetes develops, MNT interventions focus on normalization of metabolic parameters to prevent or control the complications of diabetes.

MNT for people at risk for and with diabetes should be individualized, and clinical trials and outcome studies suggest that such therapy is best provided by a registered dietitian familiar with diabetes. Monitoring of metabolic parameters, including glucose, hemoglobin A1c (A1C), lipids, blood pressure, body weight, and renal function, is essential to assess the need for changes in therapy to ensure successful outcomes. Taking into account an individual’s personal needs, willingness, and ability to change remains crucial.

Clinical trials and outcome studies of MNT have reported decreases in A1C of ~ 1% in type 1 diabetes and 1–2% in type 2 diabetes, depending on the duration of diabetes. After initiation of MNT, improvements were apparent in 6 weeks to 3 months. Meta-analysis of studies in non-diabetic, free-living subjects and expert committees report that MNT reduces LDL cholesterol by 15–25 mg/dl. Meta-analysis and expert committees also support a role for lifestyle modifications in treating hypertension.

This article highlights major points of emphasis in the 2006 recommendations and notes changes from previous recommendations.

Overweight and Obesity
The association between an elevated BMI and diabetes is well known. Less well appreciated is waist circumference as a proxy measure of visceral fat accumulation in assessing the risk of diabetes and cardiovascular disease. A waist circumference ≥ 40 inches for men and ≥ 35 inches for women indicates increased disease risk. Lower waist circumference cut points (≥ 35 inches in men and ≥ 31 inches in women) are used for Asian populations.

Structured lifestyle programs have been shown to produce long-term weight loss of 5–7% of baseline weight. Weight loss generally occurs over a 6-month period, and with support, the health benefits and much of the weight loss can be maintained. Reduced energy intake and increased physical activity are essential in achieving and maintaining weight loss. Although low-carbohydrate diets produce short-term weight loss, maintenance of weight loss is similar to that from low-fat diets, and the impact of these diets on cardiovascular risk profile is uncertain. Low-carbohydrate diets (restricting total carbohydrate to < 130 g/day) are not recommended. For some individuals, meal replacements, weight-loss medications, and bariatric surgery may be appropriate.

Pre-Diabetes
Clinical trials have strongly supported the potential for moderate weight loss...
to reduce the risk of type 2 diabetes.\(^8\) Both moderate-intensity physical activity and vigorous exercise improve insulin sensitivity, independent of weight loss, and also reduce risk. Several studies also have provided evidence for reduced risk of diabetes with increased intake of whole grains and dietary fiber. Whole grain–containing foods have been associated with improved insulin sensitivity, independent of body weight, and dietary fiber has also been associated with improved insulin sensitivity and improved ability to secrete insulin to overcome insulin resistance.

Observational studies in adults suggest a U- or J-shaped association between moderate alcohol intake (1–3 drinks [15–45 g of alcohol] per day) and decreased risk of type 2 diabetes, coronary heart disease, and stroke.\(^9\) However, the data do not support recommending alcohol consumption to people at risk for diabetes.

**Diabetes Treatment**

The optimal mix of macronutrients for people with diabetes has not been defined because the necessary randomized controlled trial would be difficult to implement. Issues to be considered for such a study include the number and characteristics of the participants, a long follow-up period, need for high rates of retention and adherence with treatment, and need for definitive outcomes, such as mortality and cardiovascular disease.

Macronutrient intake should be individualized, but the dietary reference intakes (DRIs), which suggest that to minimize the risk of chronic diseases adults should consume 45–60% of total energy from carbohydrate, 20–35% from fat, and 10–35% from protein, can provide a starting point.\(^10\) Regardless of macronutrient percentages, total energy intake must be appropriate for weight management goals.

**Carbohydrate.** The importance of foods containing carbohydrate—i.e., fruits, vegetables, whole grains, legumes, and low-fat milk—in a healthy diet is again emphasized. These foods are important sources of energy, fiber, vitamins, and minerals and contribute to the diet’s palatability. The amount of carbohydrate ingested and available insulin is the primary determinant of postprandial glucose responses. Monitoring carbohydrate consumption, either by carbohydrate counting, exchanges, or experienced-based estimation, remains a key strategy in achieving glycemic control.

The type of carbohydrate, however, can also affect postprandial glucose responses. Although several randomized clinical trials have reported that low-glycemic index diets compared to high-glycemic index diets reduce postprandial glucose responses in subjects with diabetes, other clinical trials have not confirmed this effect. Of concern is the variability in responses to specific carbohydrate-containing foods. When reported, it appears that most individuals already consume a moderate-glycemic index diet. However, it appears that in individuals consuming a high-glycemic index diet, low-glycemic index diets may provide a modest additional benefit over that observed when total carbohydrate is considered alone.

As for the general population, people with diabetes are encouraged to eat a variety of fiber-containing foods, and a first priority might be to encourage them to achieve the fiber intake goals set for the general population of 14 g per 1,000 kcal.\(^11\)

As noted in previous recommendations, sucrose-containing foods may be substituted for other carbohydrate or, if added, adequately covered with insulin or another glucose-lowering medication. Care should be taken to avoid excess energy intake. Substantial evidence demonstrates that dietary sucrose does not increase glycemia more than isocaloric amounts of starch. Sugar alcohols and nonnutritive sweeteners are safe when consumed within the daily intake levels established by the U.S. Food and Drug Administration (FDA).

**Dietary fats and cholesterol.** Several changes have been made in the dietary fat section of the recommendations. Because the cardiovascular risk of individuals with diabetes is considered to be equivalent to that of nondiabetic individuals with preexisting cardiovascular disease, it is recommended that saturated fatty acid intake be < 7% of total calories, dietary cholesterol < 200 mg/day, and intake of trans fatty acids minimized. These recommendations are based on studies done in nondiabetic individuals because studies done in people with diabetes are not available.\(^11\) Recent research has shown that polyunsaturated fatty acids have effects similar to monounsaturated fatty acids, and therefore saturated fatty acids can be replaced with either poly- or monounsaturated fatty acids. Two or more servings of fish per week (with the exception of commercially fried fish fillets) provide omega-3 fatty acids and can be recommended.

**Protein.** Protein intake usually does not exceed 20% of energy intake, and evidence is not available suggesting this should be changed in people with normal renal function. A number of studies have shown that glucose produced from ingested protein does not increase glucose levels, but it does produce acute insulin responses. Small, short-term studies in people with diabetes suggest that diets containing > 20% of total energy from protein may reduce appetite and increase satiety. However, the long-term effects are unknown, and preliminary data suggest that it may be difficult for free-living people to follow these diets over the long term.

**Alcohol.** Moderate amounts of alcohol, when ingested with food, have minimal acute effects on glucose and insulin levels. For individuals using insulin or insulin secretagogues, alcohol should be consumed with foods to avoid hypoglycemia. If adults with diabetes choose to drink alcohol, daily intake should be limited to moderate amounts (< 1 drink per day for women and < 2 drinks per day for men) and can be considered an occasional addition to the regular meal plan. In people with diabetes, light to moderate intake of alcohol is reported to improve insulin sensitivity and raise HDL cholesterol levels, is associated with reductions in blood pressure (excessive amounts increase blood pressure), does not raise triglyceride levels, and is associated with a decreased risk of coronary heart disease. The type of alcohol-containing beverage does not appear to make a difference. Abstention from alcohol is advised for people...
with a history of alcohol abuse or dependence, women during pregnancy, and people with medical problems such as liver disease, pancreatitis, advanced neuropathy, or severe hypertriglyceridemia.

**Micronutrients.** There is no clear evidence of benefit from vitamin or mineral supplementation in people with diabetes who do not have underlying deficiencies; an exception is folate for the prevention of birth defects. Routine supplementation with antioxidants is not advised. Clinical trial data not only indicate the lack of benefit with respect to glycemic control and progression of complications but also provide evidence of the potential harm of vitamin E, carotene, and other antioxidant supplements. In addition, benefit from chromium supplementation in people with diabetes or obesity has not been clearly demonstrated and is not recommended. The FDA concluded that although a small study suggested that chromium picolinate may reduce insulin resistance, the relationship between chromium picolinate and either insulin resistance or type 2 diabetes is uncertain.

**Nutrition Interventions**

**Type 1 diabetes.** MNT interventions for type 1 diabetes are similar to previous recommendations. The first priority is to integrate an insulin regimen into the individual’s lifestyle. Individuals on physiological insulin regimens or insulin pumps should adjust their mealtime rapid-acting insulin based on their planned carbohydrate intake. The Dose Adjusted for Normal Eating (DAFNE) trial done in Great Britain reported improvements in A1C of ~1% when individuals were taught to adjust their insulin dose based on their planned carbohydrate intake. They also reported a positive effect on quality of life even though increases in the number of insulin injections and blood glucose tests were necessary. For individuals using fixed insulin doses, carbohydrate intake on a day-to-day basis should be kept consistent in regard to both time and amount.

**Type 2 diabetes.** Again, the MNT interventions are similar to previous recommendations. The first MNT intervention priority is to encourage individuals with type 2 diabetes to implement lifestyle strategies that will improve glycemia, dyslipidemia, and blood pressure. MNT recommendations differ in several aspects from recommendations for the prevention of diabetes. MNT progresses from prevention of overweight and obesity, to improving insulin resistance and preventing and delaying the onset of diabetes, to contributing to improved metabolic control. Increased physical activity can lead to decreases in insulin resistance and a reduction in cardiovascular risk factors, independent of weight loss. At least 150 minutes per week of moderate-intensity physical activity, distributed over 3 days and with no more than 2 consecutive days without physical activity is recommended. Glucose monitoring can be used to determine whether adjustments in foods and meals will be beneficial or whether medication needs to be combined with MNT.

**Pregnancy.** Nutrition interventions again focus on an adequate energy intake that provides for appropriate weight gain and adequate nutrients to supply the nutritional demands of pregnancy. Weight loss is not recommended, although for overweight and obese women with gestational diabetes, modest energy and carbohydrate restriction may be appropriate. Breastfeeding is recommended.

**Older adults.** Obese older adults with type 2 diabetes may benefit from modest energy restriction and an increase in physical activity. However, an involuntary weight loss or gain of >10 lb or 10% of body weight in <6 months should be evaluated.

**Complications of Diabetes**

Progression in the diabetes complication of nephropathy may be modified by improved glycemic control, lowering of blood pressure, and potentially by reducing protein intake. Normal protein intake (15–20% of energy) does not appear to be associated with the risk of developing diabetic nephropathy, but the long-term effect on development of nephropathy of dietary protein intake >20% of energy has not been studied. Although not without controversy, reduction of protein intake to 0.8–1.0 g·wt⁻¹·day⁻¹ in individuals with diabetes and the earlier stages of chronic kidney failure and to 0.8 g·wt⁻¹·day⁻¹ in the later stages of chronic kidney failure may improve measures of renal function, such as urine albumin excretion rate and glomerular filtration rate.

Because cardiovascular disease risk factors are similar in individuals with and without diabetes, benefit observed in nutrition studies in the general population are probably applicable to individuals with diabetes as well. The need to reduce intake of saturated and trans fatty acids was addressed in the dietary fat section. In normotensive and hypertensive people, a reduced sodium intake (e.g., 2,300 mg/day), modest amounts of weight loss, and a diet high in fruits, vegetables, and low-fat dairy products lowers blood pressure. For patients with diabetes and symptomatic heart failure, dietary sodium intake of <2,000 mg/day may reduce symptoms.

**Summary**

It continues to be essential that individual outcomes from MNT be monitored so that appropriate changes in the overall management plan for diabetes can be implemented. There are many aspects of MNT for diabetes that require additional research.

**References**


DAFNE Study Group: Training in flexible, intensive insulin management to enable dietary freedom in people with type 1 diabetes: Dose Adjustment for Normal Eating (DAFNE) randomized controlled trial. *BMJ* 325:746–752, 2002

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