Nutrition Principles and Recommendations in Diabetes

AMERICAN DIABETES ASSOCIATION

Medical nutrition therapy is an integral component of diabetes management and of diabetes self-management education. Yet many misconceptions exist concerning nutrition and diabetes. Moreover, in clinical practice, nutrition recommendations that have little or no supporting evidence have been and are still being given to persons with diabetes. Accordingly, this position statement provides evidence-based principles and recommendations for diabetes medical nutrition therapy. The rationale for this position statement is discussed in the American Diabetes Association technical review "Evidence-Based Nutrition Principles and Recommendations for the Treatment and Prevention of Diabetes and Related Complications," which discusses in detail the published research for each principle and recommendation (1).

Historically, nutrition recommendations for diabetes and related complications were based on scientific knowledge, clinical experience, and expert consensus; however, it was often difficult to discern the level of evidence used to construct the recommendations. To address this problem, the 2002 technical review (1) and this position statement provide principles and recommendations classified according to the level of evidence available using the American Diabetes Association evidence grading system. However, the best available evidence must still take into account individual circumstances, preferences, and cultural and ethnic preferences, and the person with diabetes should be involved in the decision-making process. The goal of evidence-based recommendations is to improve diabetes care by increasing the awareness of clinicians and persons with diabetes about beneficial nutrition therapies.

Because of the complexity of nutrition issues, it is recommended that a registered dietitian, knowledgeable and skilled in implementing nutrition therapy into diabetes management and education, be the team member providing medical nutrition therapy. However, it is essential that all team members be knowledgeable about nutrition therapy and supportive of the person with diabetes who needs to make lifestyle changes.

GOALS OF MEDICAL NUTRITION THERAPY FOR DIABETES

Goals of medical nutrition therapy that apply to all persons with diabetes are as follows:

1. Attain and maintain optimal metabolic outcomes including
   - Blood glucose levels in the normal range or as close to normal as is safely possible to prevent or reduce the risk for complications of diabetes.
   - A lipid and lipoprotein profile that reduces the risk for macrovascular disease.
   - Blood pressure levels that reduce the risk for vascular disease.
2. Prevent and treat the chronic complications of diabetes. Modify nutrient intake and lifestyle as appropriate for the prevention and treatment of obesity, dyslipidemia, cardiovascular disease, hypertension, and nephropathy.
3. Improve health through healthy food choices and physical activity.
4. Address individual nutritional needs taking into consideration personal and cultural preferences and lifestyle while respecting the individual's wishes and willingness to change.

Goals of medical nutrition therapy that apply to specific situations include the following:

1. For youth with type 1 diabetes, to provide adequate energy to ensure normal growth and development, integrate insulin regimens into usual eating and physical activity habits.
2. For youth with type 2 diabetes, to facilitate changes in eating and physical activity habits that reduce insulin resistance and improve metabolic status.
3. For pregnant and lactating women, to provide adequate energy and nutrients needed for optimal outcomes.
4. For older adults, to provide for the nutritional and psychosocial needs of an aging individual.
5. For individuals treated with insulin or insulin secretagogues, to provide self-management education for treatment (and prevention) of hypoglycemia, acute illnesses, and exercise-related blood glucose problems.
6. For individuals at risk for diabetes, to decrease risk by encouraging physical activity and promoting food choices that facilitate moderate weight loss or at least prevent weight gain.

MEDICAL NUTRITION THERAPY FOR TYPE 1 AND TYPE 2 DIABETES

Carbohydrate and diabetes

When referring to common food carbohydrates, the following terms are preferred: sugars, starch, and fiber. Terms such as simple sugars, complex carbohy-

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Abbreviations: VLCD, very low calorie diet.

drates, and fast-acting carbohydrates are not well defined and should be avoided. Studies in healthy subjects and those at risk for type 2 diabetes support the importance of including foods containing carbohydrate, particularly from whole grains, fruits, vegetables, and low-fat milk in the diet of people with diabetes.

A number of factors influence glycemic responses to foods, including the amount of carbohydrate, type of sugar (glucose, fructose, sucrose, lactose), nature of the starch (amylose, amylopectin, resistant starch), cooking and food processing (degree of starch gelantinization, particle size, cellular form), and food form, as well as other food components (fat and natural substances that slow digestion—lectins, phytates, tannins, and starch-protein and starch-lipid combinations). Fasting and preprandial glucose concentrations, the severity of glucose intolerance, and the second meal or lente effect of carbohydrate are other factors affecting the glycemic response to foods. However, in persons with type 1 or type 2 diabetes, ingestion of a variety of starches or sucrose, both acutely and for up to 6 weeks, produced no significant differences in glycemic response if the amount of carbohydrate was similar. Studies in controlled settings and studies in free-living subjects produced similar results. Therefore, the total amount of carbohydrate in meals and snacks will be more important than the source or the type.

Studies in subjects with type 1 diabetes show a strong relationship between the premeal insulin dose and the postprandial response to the total carbohydrate content of the meal. Therefore, the premeal insulin doses should be adjusted for the carbohydrate content of the meal. For individuals receiving fixed doses of insulin, day-to-day consistency in the amount of carbohydrate is important.

In persons with type 2 diabetes, on weight maintenance diets, replacing carbohydrate with monounsaturated fat reduces postprandial glycemia and triglyceridemia. However, there is concern that increased fat intake in ad libitum diets may promote weight gain. Therefore, the contributions of carbohydrate and monounsaturated fat to energy intake should be individualized based on nutrition assessment, metabolic profiles, and treatment goals.

Glycemic index. Although low glycemic index diets may reduce postprandial glycemia, the ability of individuals to maintain these diets long-term (and therefore achieve glycemic benefit) has not been established. The available studies in persons with type 1 diabetes in which low glycemic index diets were compared with high glycemic index diets (study length from 12 days to 6 weeks) do not provide convincing evidence of benefit. In subjects with type 2 diabetes, studies of 2–12 weeks duration comparing low glycemic index and high glycemic index diets report no consistent improvements in HbA_{1c}, fructosamine, or insulin levels. The effects on lipids from low glycemic index diets compared with high glycemic index diets are mixed.

Although it is clear that carbohydrates do have differing glycemic responses, the data reveal no clear trend in outcome benefits. If there are long-term effects on glycemia and lipids, these effects appear to be modest. Moreover, the number of studies is limited, and the design and implementation of several of these studies are subject to criticism.

Fiber. As for the general population, people with diabetes are encouraged to choose a variety of fiber-containing foods, such as whole grains, fruits, and vegetables, because they provide vitamins, minerals, fiber, and other substances important for good health. Early short-term studies using large amounts of fiber in small numbers of subjects with type 1 diabetes suggested a positive effect on glycemia. Recent studies have reported mixed effects on glycemia and lipids. In subjects with type 2 diabetes, it appears that ingestion of very large amounts of fiber are necessary to confer metabolic benefits on glycemic control, hyperinsulinemia, and plasma lipids. It is not clear whether the palatability and the gastrointestinal side effects of fiber in this amount would be acceptable to most people.

Sweeteners. The available evidence from clinical studies demonstrates that dietary sucrose does not increase glycemia more than isocaloric amounts of starch. Thus, intake of sucrose and sucrose-containing foods by people with diabetes does not need to be restricted because of concern about aggravating hyperglycemia. Sucrose should be substituted for other carbohydrate sources in the food/meal plan or, if added to the food/meal plan, adequately covered with insulin or another glucose-lowering medication. Additionally, intake of other nutrients ingested with sucrose, such as fat, need to be taken into account.

In subjects with diabetes, fructose produces a lower postprandial response when it replaces sucrose or starch in the diet; however, this benefit is tempered by concern that fructose may adversely effect plasma lipids. Therefore, the use of added fructose as a sweetening agent is not recommended; however, there is no reason to recommend that people with diabetes avoid naturally occurring fructose in fruits, vegetables, and other foods.

Sugar alcohols produce a lower postprandial glucose response than fructose, sucrose, or glucose and have lower available energy values. However, there is no evidence that the amounts likely to be consumed in a meal or day result in a significant reduction in total daily energy intake or improvement in long-term glycemia. The use of sugar alcohols appears to be safe; however, they may cause diarrhea, especially in children.

The Food and Drug Administration has approved four non-nutritive sweeteners for use in the U.S.—saccharin, aspartame, acesulfame potassium, and sucralose. Before being allowed on the market, all underwent rigorous scrutiny and were shown to be safe when consumed by the public, including people with diabetes and during pregnancy.

Resistant starch. It has been proposed that foods containing naturally occurring resistant starch (cornstarch) or foods modified to contain more resistant starch (high amylose cornstarch) may modify postprandial glycemic response, prevent hypoglycemia, reduce hyperglycemia, and explain differences in the glycemic index of some foods. However, there are no published long-term studies in subjects with diabetes to prove benefit from the use of resistant starch.

RECOMMENDATIONS

A-Level evidence

- Foods containing carbohydrate from whole grains, fruits, vegetables, and low-fat milk should be included in a healthy diet.
- With regard to the glycemic effects of carbohydrates, the total amount of carbohydrate in meals or snacks is more important than the source or type.

- As sucrose does not increase glycemia to a greater extent than isocaloric amounts of starch, sucrose and sucrose-containing foods do not need to be restricted by people with diabetes; however, they should be substituted for other carbohydrate sources or, if added, covered with insulin or other glucose-lowering medication.
- Non-nutritive sweeteners are safe when consumed within the acceptable daily intake levels established by the Food and Drug Administration.

B-Level evidence

- Individuals receiving intensive insulin therapy should adjust their premeal insulin doses based on the carbohydrate content of meals.
- Although the use of low– glycemic index foods may reduce postprandial hyperglycemia, there is not sufficient evidence of long-term benefit to recommend use of low– glycemic index diets as a primary strategy in food/meal planning.
- As with the general public, consumption of dietary fiber is to be encouraged; however, there is no reason to recommend that people with diabetes consume a greater amount of fiber than other Americans.

C-Level evidence

- Individuals receiving fixed daily insulin doses should try to be consistent in day-to-day carbohydrate intake.

Expert consensus

- Carbohydrate and monounsaturated fat together should provide 60–70% of energy intake. However, the metabolic profile and need for weight loss should be considered when determining the monounsaturated fat content of the diet.
- Sucrose and sucrose-containing foods should be eaten in the context of a healthy diet.

PROTEIN AND DIABETES

In the U.S., protein intake accounts for 15–20% of average energy intake, is fairly consistent across all ages from infancy to older age, and appears to be similar in persons with diabetes. It has been assumed that in people with diabetes, abnormalities of protein metabolism were less affected by insulin deficiency and insulin resistance than glucose metabolism. However, in subjects with type 2 diabetes, it has been demonstrated that moderate hyperglycemia can contribute to an increased turnover of protein, which suggests an increased need for protein. In subjects with type 1 diabetes treated with conventional insulin therapy, short-term kinetic studies have demonstrated increased protein catabolism, suggesting that near-normal glycemia and an adequate protein intake are needed. Because most adults eat at least 50% more protein than required, people with diabetes appear to be protected against protein malnutrition when consuming a usual diet.

Dietary intake of protein is reported to be similar in patients with or without nephropathy, but in all studies, protein intake was in the range of usual intake and rarely exceeded 20% of the energy intake. Intake of protein in the usual range does not appear to be associated with the development of diabetic nephropathy. However, the long-term effects of consuming >20% of energy as protein on the development of nephropathy has not been determined, and therefore it may be prudent to avoid protein intakes >20% of total daily energy.

A number of studies in healthy subjects and in persons with controlled type 2 diabetes have demonstrated that glucose from ingested protein does not appear in the general circulation, and therefore protein does not increase plasma glucose concentrations. Furthermore, the peak glucose response to carbohydrate alone is similar to that of carbohydrate and protein, suggesting that protein does not slow the absorption of carbohydrate. In subjects with type 1 diabetes, the rate of restoration of euglycemia after hypoglycemia, time to peak glucose levels, and subsequent rate of glucose fall were similar after treatment with either carbohydrate alone or carbohydrate and protein.

The effects of protein on regulation of energy intake, satiety, and long-term weight loss have not been adequately studied. The long-term efficacy and safety of high-protein low carbohydrate diets remains unknown.

RECOMMENDATIONS

B-Level evidence

- In persons with controlled type 2 diabetes, ingested protein does not increase plasma glucose concentrations, although protein is just as potent a stimulant of insulin secretion as carbohydrate.
- For persons with diabetes, especially those not in optimal glucose control, the protein requirement may be greater than the Recommended Dietary Allowance, but not greater than usual intake.

Expert consensus

- For persons with diabetes, there is no evidence to suggest that usual protein intake (15–20% of total daily energy) should be modified if renal function is normal.
- The long-term effects of diets high in protein and low in carbohydrate are unknown. Although such diets may produce short-term weight loss and improved glycemia, it has not been established that weight loss is maintained long-term. The long-term effect of such diets on plasma LDL cholesterol is also a concern.

DIETARY FAT AND DIABETES

Fatty acids and dietary cholesterol

The primary dietary fat goal in persons with diabetes is to limit saturated fat and dietary cholesterol intake. Saturated fat is the principal dietary determinant of plasma LDL cholesterol. Furthermore, persons with diabetes appear to be more sensitive to dietary cholesterol than the general public.

In nondiabetic persons, low saturated fat and cholesterol diets decrease plasma total cholesterol, LDL cholesterol, and triglycerides with mixed effects on HDL cholesterol. Positive correlations between dietary total and saturated fat and changes in plasma total cholesterol and LDL and HDL cholesterol are observed. Adding exercise results in greater decreases in plasma total and LDL cholesterol and triglycerides and prevents the decrease in HDL cholesterol associated with low-fat diets. However, studies in persons with

diabetes demonstrating effects of specific percentages of dietary saturated fatty acids and specific amounts of dietary cholesterol are not available. Therefore, the goal for persons with diabetes remains the same as for the general population.

In metabolic study diets, in which energy intake and weight are held constant, diets low in saturated fat and high in carbohydrate or enriched with *cis*-monounsaturated fatty acids (monounsaturated fat) lower plasma LDL cholesterol equivalently. Low–saturated fat (i.e., 10% of energy) high carbohydrate diets increase postprandial levels of plasma glucose, insulin, triglycerides and, in some studies, decrease plasma HDL cholesterol when compared in metabolic studies to isocaloric high monounsaturated fat diets. However, high–monounsaturated fat diets have not been shown to improve fasting plasma glucose or HbA_{1c} values. There is concern that when such high monounsaturated fat diets are eaten ad libitum outside of a controlled setting, it may result in increased energy intake and weight gain. Therefore, both the metabolic profile and the need to lose weight will determine nutrition therapy recommendations. Furthermore, ethnic or cultural preferences may play a role in determining whether saturated fat is to be replaced with carbohydrate or monounsaturated fat.

Polyunsaturated fats have not been well studied in persons with diabetes. When compared with saturated fat, polyunsaturated fats appear to lower plasma total and LDL cholesterol, but not as well as monounsaturated fats.

N-3 polyunsaturated fatty acid supplements have been shown to lower plasma triglyceride levels in persons with type 2 diabetes. Although the accompanying rise in plasma LDL cholesterol is of concern, glucose metabolism is not likely to be adversely affected with their use. N-3 supplements may be most beneficial in the treatment of severe hypertriglyceridemia. While n-3 fatty acid studies in persons with diabetes have primarily used supplements, there is evidence from the general population that foods containing n-3 fatty acids have cardioprotective effects. Two to three servings of fish per week provide dietary n-3 polyunsaturated fat and can be recommended.

Major sources of *trans* fatty acids in the diet include products made from partially hydrogenated oils such as baked products (including crackers and other snack foods), cookies, doughnuts, breads, and products like fries or chicken fried in hydrogenated shortening. Animal sources, including dairy products, provide smaller amounts of *trans* fatty acids. The effect of *trans* fatty acids is similar to saturated fats in raising plasma LDL cholesterol. In addition, *trans* fatty acids lower plasma HDL cholesterol. Therefore, intake of *trans* fatty acids should be limited.

Plant sterol and stanol esters block the intestinal absorption of dietary and biliary cholesterol. Plant sterols/stanols in amounts of ~2 g/day have been shown to lower total and LDL cholesterol.

Low-fat diets

In studies evaluating the effect of ad libitum energy intake as a function of dietary fat content, low-fat high-carbohydrate diets are associated with a transient decrease in energy intake and modest weight loss to a new equilibrium body weight. With this modest weight loss, a decrease in plasma total cholesterol and triglycerides and an increase in HDL cholesterol occur. Consistent with this, low-fat high-carbohydrate diets over long periods of time have shown no increase in plasma triglycerides and, when reported, modest weight loss.

Fat replacements

Dietary fat intake can be reduced by lowering the amount of high fat foods in the diet or by providing lower-fat or fat-free versions of food and beverages or by using fat replacers (ingredients that mimic the properties of fat but with significantly fewer calories) in food formulations. The Food and Drug Administration provides assurance that current fat replacers/substitutes are safe to use in foods. Regular use of foods with fat replacers may help to reduce dietary fat intake (including saturated fat and cholesterol), but may not reduce total energy intake or weight. Long-term studies are needed to assess the effects of foods containing fat replacers on energy intake and on the macronutrient content of the diets of people with diabetes.

RECOMMENDATIONS

A-Level evidence

- Less than 10% of energy intake should be derived from saturated fats. Some individuals (i.e., persons with LDL cholesterol ≥100 mg/dl) may benefit from lowering saturated fat intake to <7% of energy intake.
- Dietary cholesterol intake should be <300 mg/day. Some individuals (i.e., persons with LDL cholesterol ≥100 mg/dl) may benefit from lowering dietary cholesterol to <200 mg/ day.

B-Level evidence

- To lower LDL cholesterol, energy derived from saturated fat can be reduced if weight loss is desirable or replaced with either carbohydrate or monounsaturated fat when weight loss is not a goal.
- Intake of *trans* unsaturated fatty acids should be minimized.
- Reduced-fat diets when maintained long-term contribute to modest loss of weight and improvement in dyslipidemia.
- Two to three servings of fish per week provide dietary n-3 polyunsaturated fat and can be recommended.

C-Level evidence

- Polyunsaturated fat intake should be ~10% of energy intake.

ENERGY BALANCE AND OBESITY

Because of the effects of obesity on insulin resistance, weight loss is an important therapeutic objective for persons with type 2 diabetes. Short-term studies have demonstrated that weight loss in subjects with type 2 diabetes is associated with decreased insulin resistance, improved measures of glycemia and dyslipidemia, and reduced blood pressure. However, long-term data assessing the extent to which these improvements can be maintained are not available. The reason long-term weight loss is difficult for most people to accomplish is probably because energy intake, energy expenditure and thereby body weight are regulated by the central nervous system. This regulation appears to be influenced by genetic factors. Furthermore, environmental factors often

make losing weight difficult for those genetically predisposed to obesity.

Evidence demonstrates that structured, intensive lifestyle programs involving participant education, individualized counseling, reduced dietary fat and energy intake, regular physical activity, and frequent participant contact are necessary to produce long-term weight loss of as much as 5–7% of starting weight. When dieting to lose weight, fat is probably the most important nutrient to restrict. Spontaneous food consumption and total energy intake are increased when the diet is high in fat and decreased when the diet is low in fat. Exercise by itself has only a modest effect on weight loss. However, exercise is to be encouraged because it improves insulin sensitivity, acutely lowers blood glucose, and is important in long-term maintenance of weight loss. Weight loss with behavioral therapy alone also has been modest, and behavioral approaches may be most useful as an adjunct to other weight loss strategies. However, optimal strategies for preventing and treating obesity long-term have yet to be defined.

Standard weight loss diets provide 500–1,000 fewer calories than estimated to be necessary for weight maintenance. Although many people can lose some weight (as much as 10% of initial weight) with such diets, the medical literature documents that without the other components of an intensive lifestyle program, long-term outcomes are poor. The majority of people regain the weight they have lost.

Meal replacements provide a defined amount of energy often as a formula product. Use of meal replacements once or twice daily to replace a usual meal can result in significant weight loss, but meal replacement therapy must be continued if weight loss is to be maintained. Very low calorie diets (VLCDs) provide 800 or fewer calories daily and produce substantial weight loss and rapid improvements in glycemia and lipemia in persons with type 2 diabetes. When VLCDs are stopped and self-selected meals are reintroduced, weight gain is common. Thus, VLCDs appear to have limited utility in the treatment of type 2 diabetes and should only be considered in conjunction with a structured weight maintenance program.

The available data suggest that weight loss medications may be useful in the treatment of overweight persons with type 2 diabetes. However, their effect is modest. Moreover, the available data suggest that these medications only work as long as they are taken and should be used in conjunction with lifestyle strategies. These drugs should be used only in people with BMI >27.0 kg/m^2.

Although gastric reduction surgery can be an effective weight loss treatment for severe obesity (including severe obesity in persons with type 2 diabetes), this surgery should only be considered for patients with a BMI ≥ 35 kg/m^2. There are no data comparing medical and surgical approaches to weight loss, and thus the relative benefits and risks of surgical approaches are uncertain. Therefore, gastric reduction surgery should be considered unproven in treating diabetes.

RECOMMENDATIONS

A-Level evidence

- In insulin-resistant individuals, reduced energy intake and modest weight loss improve insulin resistance and glycemia in the short-term.
- Structured programs that emphasize lifestyle changes, including education, reduced fat ($<30\%$ of daily energy) and energy intake, regular physical activity, and regular participant contact, can produce long-term weight loss on the order of 5–7% of starting weight.
- Exercise and behavior modification are most useful as adjuncts to other weight loss strategies. Exercise is helpful in maintenance of weight loss.
- Standard weight reduction diets, when used alone, are unlikely to produce long-term weight loss. Structured intensive lifestyle programs are necessary.

MICRONUTRIENTS AND DIABETES

Persons with diabetes should be educated about the importance of consuming adequate amounts of vitamins and minerals from natural food sources as well as the potential toxicity of megadoses of vitamin and mineral supplements. Although difficult to ascertain, if deficiencies of vitamins and minerals are identified, supplementation can be beneficial. Select populations, such as the elderly, pregnant or lactating women, strict vegetarians, and those on calorie-restricted diets, may benefit from supplementation with a multivitamin preparation.

Because diabetes may be a state of increased oxidative stress, there has been interest in prescribing antioxidant vitamins to people with diabetes. In general, megadoses of dietary antioxidants—vitamin C, vitamin E, selenium, beta carotene, and other carotenoids—have not demonstrated protection against cardiovascular disease, diabetes, or cancer. Although large observational studies have shown a correlation between dietary or supplemental consumption of antioxidants and cardiovascular benefit, large placebo-controlled trials have failed to show a benefit and, in some instances, have suggested adverse effects of antioxidant vitamins.

The role of folate in preventing birth defects is widely accepted, but the role of folate supplementation to lower homocysteine and to reduce cardiovascular events is not clear. The role of vitamins B1, B6, and B12 in the treatment of diabetic neuropathy has not been established and cannot be recommended as a routine therapeutic option. The use of nicotinamide to preserve β-cell mass in newly diagnosed subjects with type 1 diabetes is under investigation; however, a beneficial effect has not been clearly demonstrated.

Deficiencies of certain minerals, such as potassium, magnesium, and possibly zinc and chromium, may aggravate carbohydrate intolerance. Whereas the need for potassium or magnesium replacement is relatively easy to detect based on low serum levels, the need for zinc or chromium supplementation is more difficult to detect.

Beneficial effects on glycemia from chromium supplementation have been reported. However, the populations studied may have had marginal baseline chromium status, and in the largest study, chromium status was not evaluated either at baseline or following supplementation. Other well-designed studies have failed to show any significant benefit from chromium supplementation on glycemic control in people with diabetes. At the present, benefit from chromium supplementation in persons with diabetes has not been conclusively demonstrated.

A daily intake of 1,000–1,500 mg of calcium, especially in older subjects with diabetes, is recommended. This recommendation appears to be safe and likely to reduce osteoporosis in older persons. The

value of calcium supplementation in younger persons is uncertain.

The role of vanadium salts in diabetes has been explored. There is no clear evidence of efficacy, and there is potential for toxicity. A variety of herbal preparations have been shown to have modest beneficial effects on glycemia. However, commercially available products are not well standardized and vary greatly in the content of active ingredients. In persons with diabetes, there is no evidence to suggest long-term benefit from herbal preparations. They also have the potential to interact with medications. Therefore, it is important that health care providers be aware when patients with diabetes are using these products.

There is no clear evidence of benefit from vitamin or mineral supplementation in people with diabetes who do not have underlying deficiencies. Exceptions include folate for prevention of birth defects and calcium for prevention of bone disease.

RECOMMENDATIONS

B-Level evidence

- There is no clear evidence of benefit from vitamin or mineral supplementation in people with diabetes who do not have underlying deficiencies. Exceptions include folate for prevention of birth defects and calcium for prevention of bone disease.
- Routine supplementation of the diet with antioxidants is not advised because of uncertainties related to long-term efficacy and safety.

ALCOHOL AND DIABETES

For persons with diabetes, the same precautions apply regarding the use of alcohol that apply to the general population. Abstention from alcohol should be advised for women during pregnancy and for people with other medical problems such as pancreatitis, advanced neuropathy, severe hypertriglyceridemia, or alcohol abuse. If individuals choose to drink alcohol, no more than two alcohol containing drinks per day for adult men and no more than one drink per day for adult women is recommended. One drink, or alcoholic beverage, is commonly defined as 12 oz of beer, 5 oz of wine, or 1.5 oz of distilled spirits, each of which contains ~15 g of alcohol. The cardioprotective effects of alcohol appear not to be determined by the type of alcoholic beverage consumed.

Alcohol can have both hypoglycemic and hyperglycemic effects in people with diabetes. These effects are determined by the amount of alcohol acutely ingested, if consumed with or without food and if use is chronic and excessive. In studies using moderate amounts of alcohol ingested with food in people with type 1 or type 2 diabetes, alcohol had no acute effect on blood glucose or insulin levels. Therefore, alcoholic beverages should be considered an addition to the regular food/meal plan for all people with diabetes, and no food should be omitted.

Heavy or excessive alcohol consumption is a leading avoidable cause of death in the U.S. However, epidemiological evidence in nondiabetic persons suggests that light-to-moderate alcohol ingestion in adults is associated with increased insulin sensitivity and decreased risk of type 2 diabetes, coronary heart disease, and stroke. In adults with diabetes, chronic intake of light-to-moderate amounts (5–15 g/day) was associated with decreased risk for coronary heart disease, presumably due to the concomitant increase in plasma HDL cholesterol. There appears to be a U- or J-shaped relationship of alcohol intake and blood pressure. While light-to-moderate amounts of alcohol do not raise blood pressure, a strong association exists between chronic excessive intake of alcohol (>30–60 g/day) and blood pressure in men and women.

RECOMMENDATIONS

B-Level evidence

- If individuals choose to drink alcohol, daily intake should be limited to one drink for adult women and two drinks for adult men. One drink is defined as 12 oz of beer, 5 oz of wine, or 1.5 oz of distilled spirits.
- To reduce risk of hypoglycemia, alcohol should be consumed with food.

SPECIAL CONSIDERATIONS FOR TYPE 1 DIABETES

Nutrition recommendations for a healthy lifestyle for the general public are also appropriate for persons with type 1 diabetes. What differs for individuals requiring insulin is the integration of an insulin regimen into their lifestyle. With the many insulin options now available, an appropriate insulin regimen can usually be developed to conform to an individual's preferred meal routine and food choices. For persons receiving intensive insulin therapy, the total carbohydrate content of meals (and snacks) is the major determinant of the premeal insulin dose and postprandial glucose response. For persons receiving fixed insulin regimens and not adjusting premeal insulin doses, consistency of carbohydrate intake is recommended.

Improved glycemic control with insulin therapy is often associated with increased body weight. Because of the potential for weight gain to adversely affect glycemia, lipids, blood pressure, and general health, prevention of weight gain is desirable. Although the carbohydrate content of the meal determines the premeal insulin dose, attention should also be paid to total energy intake from protein and fat.

For planned exercise, reduction in insulin dosage may be the preferred choice to prevent hypoglycemia. Additional carbohydrate may be needed for unplanned exercise. Moderate-intensity exercise increases glucose uptake by 2–3 $mg \cdot kg^{-1} \cdot min^{-1}$ above usual requirements. Thus, a 70-kg person would need 8.4–12.6 g (10–15) carbohydrate per hour of moderate physical activity. More carbohydrate would be needed for intense activity (2).

SPECIAL CONSIDERATIONS FOR TYPE 2 DIABETES

Nutrition recommendations for a healthy lifestyle for the general public are also appropriate for persons with type 2 diabetes. Because many persons with type 2 diabetes are overweight and insulin resistant, medical nutrition therapy should emphasize lifestyle changes that result in reduced energy intake and increased energy expenditure through physical activity. Many people with diabetes also have dyslipidemia and hypertension, making reductions in dietary intake of saturated fat, cholesterol, and sodium desirable. Therefore, the emphasis of nutrition therapy for type 2 diabetes is on lifestyle strategies to reduce glycemia, dyslipidemia, and blood pressure. These strategies should be implemented as soon as the diagnosis of diabetes is made.

Increased physical activity can lead to

improved glycemia, decreased insulin resistance, and reduced cardiovascular risk factors. Division of food intake, three meals or smaller meals and snacks, should be based on individual preferences. Treatment with insulin or insulin secretagogues requires consistency in timing of meals and carbohydrate content. Multiple insulin dosing regimens allow for a more flexible food intake and lifestyle in persons with type 2 diabetes.

MEDICAL NUTRITION THERAPY FOR SPECIAL POPULATIONS

Children and adolescents with diabetes

Nutrition recommendations for children and adolescents with type 1 diabetes should focus on achieving blood glucose goals that maintain normal growth and development without excessive hypoglycemia. This can be accomplished through individualized food and meal planning, flexible insulin regimens and algorithms, self-blood glucose monitoring, and education-promoting decision-making based on outcomes.

Nutrient requirements for children and adolescents with type 1 or type 2 diabetes appear to be similar to other same age children and adolescents. Careful consideration of a child's appetite must be used when determining energy requirements. The ideal method for estimating a child's or adolescent's energy needs is a food/nutrition history of a typical daily intake, providing that growth and development are within normal limits. An evaluation of weight gain and growth begins at diagnosis by recording height and weight on pediatric growth charts. Adequacy of energy intake can be evaluated by following weight gain and growth patterns on a regular basis.

Withholding food or having a child eat consistently without an appetite for food in an effort to control blood glucose should be discouraged. Macronutrient composition of the nutrition prescription should be individualized according to blood glucose and plasma lipid goals and requirements for growth and development.

Nutrition recommendations for youth with type 2 diabetes focuses on treatment goals to normalize glycemia and facilitate a healthy lifestyle (3). Successful treatment with nutrition therapy and physical activity can be defined as cessation of excessive weight gain with normal linear growth and achievement of blood glucose goals. Nutrition recommendations should also address associated cardiovascular risk factors such as hypertension and dyslipidemia. Behavior modification strategies to decrease high-energy high-fat food intake while encouraging healthy eating habits and regular physical activity for the entire family should be considered.

Individualized food/meal plans and intensive insulin regimens can provide flexibility for children and adolescents with diabetes to accommodate irregular meal times and schedules, varying appetite, and varying activity levels.

RECOMMENDATIONS

Expert consensus

- Individualized food/meal plans and intensive insulin regimens can provide flexibility for children and adolescents with diabetes to accommodate irregular meal times and schedules, varying appetite, and varying activity levels.
- Nutrient requirements for children and adolescents with type 1 or type 2 diabetes appear to be similar to other same age children and adolescents.

PREGNANCY AND LACTATION WITH DIABETES

The goals of medical nutrition therapy for pregnancy are to provide adequate maternal and fetal nutrition, energy intake for appropriate weight gain, and any necessary vitamin and mineral supplements. During pregnancy complicated by diabetes, medical nutrition therapy is also important in achieving and maintaining optimal glycemic control.

Unless a woman begins pregnancy with depleted body reserves, energy needs do not increase in the first trimester. An additional 300 kcal/day are suggested during the second and third trimester for increases in maternal blood volume and increases in breast, uterus and adipose tissue, placental growth, fetal growth, and amniotic fluids. However, successful pregnancy outcomes have been reported with lower energy intakes.

In addition to adequate energy intake, pregnant women need to eat a healthy diet with adequate protein ($0.75\ g \cdot kg^{-1} \cdot day^{-1}$ plus an additional 10 g/day). Nutrient requirement during pregnancy and lactation are similar for women with and without diabetes. For all women who are capable of becoming pregnant, 400 μg/day of folic acid from fortified foods and/or a supplement, as well as food folate from a variety of foods, is recommended for the prevention of neural tube defects and other congenital abnormalities. During pregnancy, a healthy diet resulting in appropriate weight gain generally supplies all vitamins and minerals needed. There is inadequate evidence to support prenatal vitamin-mineral supplementation; however, they are often prescribed because of uncertainty of nutrition status and intake. Assessment of the pregnant woman's eating patterns may yield specific individual needs.

The Food and Drug Administration has approved four non-nutritive sweeteners, which are safe to use during pregnancy. As with nondiabetic women, women with diabetes should avoid alcoholic beverages during pregnancy.

Pregnancy with prior-onset type 1 or type 2 diabetes

Prepregnancy nutrition therapy includes an individual prenatal food/meal plan to optimize blood glucose control. During pregnancy, the distribution of the energy intake and carbohydrates in the meal plan should be based on the woman's food and eating habits, blood glucose records, and the expected physiological effects of pregnancy on her body. Regular meals and snacks are important to avoid hypoglycemia due to the continuous fetal draw of glucose from the mother. An evening snack is usually necessary to decrease the potential for overnight hypoglycemia and fasting ketosis. Blood glucose monitoring and daily food records provide valuable information for insulin and meal plan adjustments.

Gestational diabetes mellitus

Nutrition therapy for gestational diabetes promotes nutrition for maternal and fetal health with adequate energy levels for appropriate gestational weight gain, achievement and maintenance of normoglycemia, and absence of ketones. Carbohydrate is distributed throughout the day into three small-to-moderate sized meals and 2–4 snacks. An evening snack may be needed to prevent accelerated ketosis overnight. Carbohydrate is generally less

well tolerated at breakfast than at other meals. Specific nutrition and food recommendations are determined and modified based on individual assessment and self-blood glucose monitoring data.

Energy intake should provide for a desirable weight gain during pregnancy. Hypocaloric diets in obese women with gestational diabetes result in ketonemia and ketonuria. A more modest energy restriction (30% calorie-restriction of estimated energy needs) appears to reduce mean blood glucose levels without elevation in plasma free fatty acids or ketonuria. Daily food records, weekly weight checks, and ketone testing can be used to determine individual energy recommendations and whether a woman is undereating to avoid insulin therapy.

Regular aerobic exercise has been shown to lower fasting and postprandial glucose concentrations and may be used as an adjunct to nutrition therapy to improve maternal glycemia. There is insufficient evidence to recommend any specific type of exercise. Blood glucose data are necessary to evaluate the effectiveness of nutrition therapy, exercise, and the need for pharmacological therapy. If insulin therapy is added to nutrition therapy, maintaining carbohydrate consistency at meals and snacks to facilitate insulin adjustments becomes a primary goal.

Although most women with gestational diabetes revert to normal glucose tolerance postpartum, they are at increased risk of developing gestational diabetes in subsequent pregnancies and type 2 diabetes later in life. Lifestyle modifications aimed at reducing or preventing weight gain and increasing physical activity after pregnancy is recommended and can reduce the risk of subsequent diabetes.

Lactation

Breastfeeding is recommended for women with pre-existing diabetes or gestational diabetes; however, successful lactation requires planning and coordination of care. Breastfeeding lowers blood glucose, often requiring insulin-treated women to eat a snack containing carbohydrate either before or during breastfeeding. Energy requirements during the first 6 months of lactation require an additional ~200 calories above the pregnancy meal plan. However, an energy intake of ~1,800 kcal/day usually meets the nutritional requirements for lactation and may allow for a gradual weight loss.

RECOMMENDATIONS

Expert opinion

- Nutrition requirements during pregnancy and lactation are similar for women with and without diabetes.
- Medical nutrition therapy for gestational diabetes focuses on food choices for appropriate weight gain, normoglycemia, and absence of ketones.
- For some women with gestational diabetes, modest energy and carbohydrate restriction may be appropriate.

OLDER ADULTS WITH DIABETES

There is limited research on changing nutritional needs with aging and virtually none in subjects with diabetes. Therefore, nutrition recommendations for older adults with diabetes must be extrapolated from what is known from the general population. The most reliable indicator of poor nutritional status in the elderly is probably a change in body weight. In general, involuntary gain or loss of >10 pounds or 10% body weight in <6 months indicates a need to evaluate if the reason is nutrition-related.

The need for weight loss in overweight older adults should be carefully evaluated. Older people with diabetes, especially those in long-term care facilities, tend to be underweight rather than overweight. Low body weight has been associated with greater morbidity and mortality in this age group.

Exercise training can significantly reduce the decline in maximal aerobic capacity (V_{O_2}) that occurs with age, improve risk factors for atherosclerosis, slow the decline in age-related lean body mass, decrease central adiposity, and improve insulin sensitivity; all of which is beneficial for the older adult with diabetes.

A daily multivitamin supplement may be appropriate for older adults, especially those with reduced energy intake. All older adults should be advised to have a calcium intake of at least 1,200 mg daily.

The imposition of dietary restrictions on elderly residents with diabetes in long-term health facilities is not warranted. Malnutrition and dehydration may develop because of lack of food choices, poor quality of food, and unnecessary restrictions. Specialized diabetic diets do not appear to be superior to standard (regular) diets in such settings. Therefore, it is recommended that residents are served the regular (unrestricted) menu with consistency in the amount and timing of carbohydrate. There is no evidence to support diets such as "no concentrated sweets" or "no sugar added," which are often served to the elderly in long-term care facilities. Furthermore, it may often be preferable to make medication changes to control blood glucose than to implement food restrictions.

RECOMMENDATIONS

A-Level evidence

- Energy requirements for older adults are less than for younger adults.
- Physical activity should be encouraged.

Expert consensus

- In the elderly, undernutrition is more likely than overnutrition, and therefore caution should be exercised when prescribing weight loss diets.

MEDICAL NUTRITION THERAPY FOR THE TREATMENT/PREVENTION OF ACUTE COMPLICATIONS OF DIABETES AND CO-MORBID CONDITIONS

Acute complications

Hypoglycemia. Changes in food intake, physical activity, and medication(s) can contribute to the development of hypoglycemia. Treatment of hypoglycemia requires ingestion of glucose or carbohydrate-containing foods. The acute glycemic response correlates better with the glucose content than with the carbohydrate content of the food. With insulin-induced hypoglycemia, 10 g of oral glucose can raise blood glucose levels by ~40 mg/dl (2.2 mmol/l) over 30 min, and 20 g of oral glucose can raise blood glucose levels by ~60 mg/dl (3.3 mmol/l) over 45 min. In each case, glucose levels begin to fall at ~60 min after glucose ingestion (4).

Although pure glucose may be the preferred treatment, any form of carbohydrate that contains glucose will raise blood glucose. Adding protein to the carbohydrate treatment of hypoglycemia

does not affect the glycemic response and does not prevent subsequent hypoglycemia. Adding fat, however, may retard the acute glycemic response. During hypoglycemia, gastric emptying rates are twice as high as during euglycemia and are similar for liquids and for solid foods.

Acute illness. Acute illness in persons with type 1 diabetes can increase the risk for diabetic ketoacidosis. During acute illness the need for insulin continues. Furthermore, associated increased levels of counterregulatory hormones may increase insulin requirements. Testing blood glucose, testing blood or urine for ketones, drinking adequate amounts of fluid, and ingesting carbohydrate, especially if blood glucose level is <100 mg/dl (5.5 mmol/l), are important during an acute illness. In adults, ingestion of ~150–200 g carbohydrate daily (45–50 g, or three to four carbohydrate choices, every 3–4 h) should be sufficient, along with medication adjustments, to keep glucose in the goal range and to prevent starvation ketosis.

RECOMMENDATIONS

A-Level evidence

- Glucose is the preferred treatment for hypoglycemia, although any form of carbohydrate that contains glucose may be used.

B-Level evidence

- Ingestion of 15–20 g of glucose is an effective treatment, but blood glucose may only be temporarily corrected.
- During acute illnesses, testing blood glucose and blood or urine for ketones, drinking adequate amounts of fluids, and ingesting carbohydrate are important.

Expert consensus

- Initial response to treatment for hypoglycemia should be seen in ~10–20 min; however, blood glucose should be evaluated again in ~60 min, as additional treatment may be necessary.

HYPERTENSION

Medical nutrition therapy for the management of hypertension has focused on weight reduction and reducing sodium intake. Other variables that have been considered include alcohol, potassium, calcium, and diet composition (total fat, saturated fat, and cholesterol). A low-fat diet that includes fruits and vegetables (five to nine servings/day) and low-fat dairy products (two to four servings/day) will be rich in potassium, magnesium, and calcium and modestly reduce blood pressure. There are few studies done exclusively in subjects with diabetes.

Response to sodium reduction may be greater in subjects who are "salt sensitive," a factor that may apply to many individuals with diabetes. Currently, there is no available routine clinical measure to identify persons who may be salt sensitive. Several meta-analyses and reviews have documented the relationship between sodium intake and blood pressure. The mean effect of a moderate sodium restriction is reported to be a reduction of ~5 mmHg for systolic and ~2 mmHg for diastolic blood pressure in hypertensive subjects and a reduction of ~3 mmHg for systolic and ~1 mmHg for diastolic blood pressure in normotensive subjects. Three levels of sodium intake were compared in a diet containing fruits, vegetables, and low-fat dairy products and low in total fat, saturated fat, and cholesterol. The lower the sodium intake, the greater the lowering of blood pressure (5).

There is a general association in people with diabetes between weight reduction and a reduction in blood pressure, but there is great variability in the response. Reduction in blood pressure can occur with a modest amount of weight loss.

An association between high alcohol intake (≥3 drinks/day) and elevated blood pressure has been reported; however, there is no major difference in blood pressure between people who consume <3 drinks/day and nondrinkers.

Clinical trials have reported a beneficial effect of potassium supplementation on lowering blood pressure, whereas evidence for a beneficial effect from calcium and magnesium supplementation are lacking.

RECOMMENDATIONS

A-Level evidence

- In both normotensive and hypertensive individuals, a reduction in sodium intake lowers blood pressure.
- A modest amount of weight loss beneficially affects blood pressure.

Expert consensus

- The goal should be to reduce sodium intake to 2,400 mg (100 mmol) or sodium chloride (salt) to 6,000 mg/day.

DYSLIPIDEMIA

Dyslipidemia (abnormal lipid levels, lipoprotein composition, or both) is often found in persons with type 1 and type 2 diabetes. For most individuals with type 1 diabetes, effective insulin therapy usually returns lipid levels to normal and usually lowers plasma triglycerides. Plasma LDL cholesterol may decrease modestly as well.

In adult individuals with elevated plasma LDL cholesterol, saturated fatty acids should be limited to <10% and preferably to <7% of energy intake. Intakes of *trans* fatty acids should be limited. If saturated fat is replaced, it can be replaced with either carbohydrates or monounsaturated fats. Plasma LDL cholesterol lowering can be enhanced by the addition of plant stanols/sterols and by an increase in soluble (viscous) fiber.

Obese persons with type 1 diabetes and many persons with type 2 diabetes manifest a dyslipidemia with increased plasma triglycerides, reduced HDL cholesterol, and small dense LDL particles that persists despite improved glycemic control. This dyslipidemia is strongly associated with increased body adiposity that is abdominally (viscerally) distributed. For these persons, recommended lifestyle changes include *1*) reducing saturated fat to <7% of energy and dietary cholesterol to <200 mg/day, *2*) increasing viscous (soluble) fiber (10–25 g/day) and plant stanols/sterols (2 g/day) to enhance plasma LDL cholesterol lowering, *3*) modest weight loss, and *4*) increased physical activity. Dietary fat restriction and weight loss will lead to decreased plasma triglycerides and a modest lowering of plasma LDL cholesterol. Replacing saturated fat with carbohydrate has been shown by most, but not all, studies to result in improvements in plasma LDL cholesterol with beneficial or neutral effects on plasma triglycerides. Monounsaturated fat can also be substituted for saturated fat. However, increasing dietary fat can lead to an increase in energy intake and weight gain. Regular physical activity

will also reduce plasma triglycerides and improve insulin sensitivity.

For patients with persistently elevated plasma triglycerides despite the addition of medication, supplementation with fish oils that include n-3 fatty acids may be recommended. However, fish oils may increase plasma LDL cholesterol, so monitoring is required. Patients with plasma triglycerides >1,000 mg/dl are at increased risk for chylomicronemia syndrome and pancreatitis and should have restriction of all types of dietary fat and institution of lipid-lowering medication.

RECOMMENDATIONS

B-Level evidence

- For persons with elevated plasma LDL cholesterol, saturated fatty acids and *trans*-saturated fatty acids should be limited to <10% and perhaps to <7% of energy.
- For persons with elevated plasma triglycerides, reduced HDL cholesterol, and small dense LDL cholesterol (the metabolic syndrome), improved glycemic control, modest weight loss, dietary saturated fat restriction, increased physical activity, and incorporation of monounsaturated fats may be beneficial.

Expert consensus

- Energy derived from saturated fat can be reduced if weight loss is desirable or replaced with either carbohydrates or monounsaturated fats if weight loss is not a goal.

NEPHROPATHY

Several dietary factors have been identified as having a role in the prevention of nephropathy. In persons with type 1 or type 2 diabetes who have microalbuminuria, even small reductions in protein intake have been shown to improve glomerular filtration rate and to reduce urinary albumin excretion rates. Studies in subjects with type 1 diabetes and macroalbuminuria (overt nephropathy) showed a slowing of the decline in glomerular filtration rate with dietary protein reduction to 0.8 $g \cdot kg^{-1} \cdot day^{-1}$. However, such reductions should take into account the need to maintain good nutritional status in patients with chronic renal failure. Protein restriction and other renal disease meal plans should be designed by a registered dietitian familiar with medical nutrition therapy for diabetes.

Several studies have explored the potential benefit of plant protein rather than animal protein in renal insufficiency. Long-term clinical trials are needed in subjects with diabetes and nephropathy to determine whether ingestion of or reductions in certain types of protein have a beneficial effect.

RECOMMENDATIONS

C-Level evidence

- In individuals with microalbuminuria, reduction of protein to 0.8–1.0 $g \cdot kg^{-1} \cdot$ body wt^{-1}per day and in individuals with overt nephropathy, reduction to 0.8 $g \cdot kg^{-1} \cdot$ body wt^{-1} per day may slow the progression of nephropathy.

CATABOLIC ILLNESS

Catabolic disease states result in a change in body compartments that may be characterized by an increased extracellular fluid compartment (frequently with an actual increase in body weight) and an associated shrinkage of body fat and body cell mass. The magnitude of recent weight loss, taking into account the presence of excess fluid along with the presence or absence of clinical markers of stress and the amount of time the patient will be unable to eat, should determine the need for nutrition intervention. A recent weight loss in excess of 10% necessitates a thorough nutrition assessment. Unintentional weight loss of 10–20% suggests moderate protein-calorie malnutrition, whereas a loss of >20% usually indicates severe malnutrition.

A standard enteral formula (50% carbohydrate) or a lower-carbohydrate (33–40% carbohydrate) formula may be used in individuals with diabetes. Careful monitoring of vital signs, hemodynamic data, weight, fluid balance, plasma glucose and electrolytes, and acid-based status is essential. Medications, usually insulin, may need to be adjusted to maintain glycemic control. The needs of most hospitalized patients can be met by providing 25–35 kcal/kg body wt. Care should be taken not to overfeed because this can exacerbate hyperglycemia, cause abnormal liver function, and increase oxygen consumption and carbon dioxide production. Protein needs are ~1.0 $g \cdot kg^{-1} \cdot$ body wt^{-1} for mildly stressed patients and 1.5 g/kg for moderately to severely stressed patients with normal hepatic and renal function. At least 30% of total energy should be given as lipids.

RECOMMENDATIONS

Expert consensus

- The energy needs of most hospitalized patients can be met by providing 25–35 kcal/kg body wt.
- Protein needs are between 1.0 and 1.5 g/kg body wt; the higher end of the range being for more stressed patients.

DIABETES PREVENTION

The importance of prevention of diabetes in high-risk individuals is highlighted by the substantial and worldwide increase in the prevalence of diabetes in recent years. Genetic susceptibility appears to play a powerful role in the occurrence of type 2 diabetes in certain populations. However, given that population gene pools shift quite slowly, the current epidemic likely reflects marked changes in lifestyle. Lifestyle changes that are characterized by decreased physical activity and increased energy consumption have together promoted obesity, which is a strong risk factor for diabetes that itself is influenced by both genes and behavior. Despite the difficulty in maintaining a reduced body weight long-term, several studies have demonstrated the potential for moderate sustained weight loss to substantially reduce the risk for type 2 diabetes. Clinical trial data from both the U.S. and Finland now strongly support the potential for moderate weight loss to reduce the risk for diabetes (6,7). An active lifestyle also has been demonstrated in a number of prospective studies to prevent or delay the development of type 2 diabetes. Both moderate and vigorous exercise decrease risk of impaired glucose tolerance and type 2 diabetes.

Reduced intake of total fat, particularly saturated fat, may reduce risk for diabetes. Increased diabetes incidence is reported with increased intake of dietary fat, independent of total calories, although this effect is not demonstrated in all studies. It appears that all types of dietary fat (except n-3 fatty acids) may have an adverse effect on insulin sensitivity. Saturated fat may have the greatest effect. Increased intake of polyunsaturated fat, in the context of appropriate total energy

intake for weight management, may reduce the risk for type 2 diabetes.

Recent studies have provided evidence for reduced risk of diabetes with increased intake of whole grains and dietary fiber. Although selected micronutrients may affect glucose and insulin metabolism, data to document their role in the development of diabetes are scant or inconsistent. Moderate alcohol intake has been related to improved insulin sensitivity and reduced risk for diabetes. However, insufficient data exist to support a specific recommendation for moderate alcohol intake for prevention of type 2 diabetes.

No nutritional recommendations can be made for prevention of type 1 diabetes. Breastfeeding may be beneficial. Although increasing obesity in youth may be related to an increase in the prevalence of type 2 diabetes, particularly in minority adolescents, there is insufficient data at present to warrant any specific recommendations for prevention of type 2 diabetes in youth. Increased physical activity, reduced energy and fat intake, and resultant weight management may prove to be beneficial.

RECOMMENDATIONS

A-Level evidence

- Structured programs that emphasize lifestyle changes, including education, reduced fat and energy intake, regular physical activity, and regular participant contact, can produce long-term weight loss of 5–7% of starting weight and reduce the risk for developing diabetes.

B-Level evidence

- All individuals, especially family members of persons with type 2 diabetes, should be encouraged to engage in regular physical activity to decrease risk of developing type 2 diabetes.

SUMMARY

Medical nutrition therapy for people with diabetes should be individualized, with consideration given to the individual's usual food and eating habits, metabolic profile, treatment goals, and desired outcomes. Monitoring of metabolic parameters, including glucose, HbA_{1c}, lipids, blood pressure, body weight, and renal function, when appropriate, as well as quality of life, is essential to assess the need for changes in therapy and to ensure successful outcomes. Ongoing nutrition self-management education and care needs to be available for individuals with diabetes. In addition, many areas of nutrition and diabetes require additional research.

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