

Dietary interference for the prevention of type 2 diabetes

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Abstract

Medical nutrition therapy (MNT) provided by a registered dietician into primary care of type 2 diabetes mellitus (T2DM). This is necessary to achieve the goals of improving overall metabolic measures beyond calorie restriction and weight loss. Misconceptions about nutrition in T2DM add to the challenges of executing MNT in a culturally sensitive population. The current review provides insights into MNT for the prevention and management of T2DM based on both evidence and experience. It revisits historical Indian studies and provides information on appropriate dietary intake of carbohydrates (60–70%), proteins 20% and fats 10% that will be acceptable and beneficial in T2DM population. It discusses nuances of types of carbohydrates and fats and explains associations of increased dietary fiber intake, balanced intake of low and high glycemic index foods and substitution of saturated fats with plant-based polyunsaturated fats in improving outcomes of T2DM and attenuating risk factors. The article also deliberates upon special patient populations with comorbid conditions and diseases and the necessary adjustments needed in their nutritional care.

Keywords: Medical nutrition therapy; Type 2 diabetes mellitus; Metabolic measures; Misconceptions

1. Introduction

Medical nutrition therapy (MNT) is important in preventing diabetes, managing existing diabetes, and preventing, or at least slowing, the rate of development of diabetes complications. It is, therefore, important at all levels of diabetes prevention. MNT is also an integral component of diabetes self-management education (or training). This position statement provides evidence-based recommendations and interventions for diabetes MNT. The previous position statement with accompanying technical review was published in 2002."1". and modified slightly in 2004 , This statement updates previous position statements, focuses on key references published since the year 2000, and uses grading according to the level of evidence available based on the American Diabetes Association evidence-grading system. Since overweight and obesity are closely linked to diabetes, particular attention is paid to this area of MNT. The goal of these recommendations is to make people with diabetes and health care providers aware of beneficial nutrition interventions. This requires the use of the best available scientific evidence while taking into account treatment goals, strategies to attain such goals, and changes individuals with diabetes are willing and able to make. Achieving nutrition-related goals requires a coordinated team effort that includes the person with diabetes and involves him or her in the decision-making process. It is recommended that a registered dietitian, knowledgeable and skilled in MNT, be the team member who plays the leading role in providing nutrition care. However, it is important that all team members, including physicians and nurses, be knowledgeable about MNT and supports its implementation. MNT, as illustrated in Table 1, plays a role in all three levels of diabetes-related prevention targeted by the U.S. Department of Health and Human Services. Primary prevention interventions seek to delay or halt the development of diabetes. This involves public health measures to reduce the prevalence of obesity and includes MNT for individuals with prediabetes. Secondary and tertiary prevention interventions include MNT for individuals with diabetes and seek to prevent (secondary) or control (tertiary) complications of diabetes."2".

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2. Goals of nutritional therapy for prevention and treatment of diabetes

Goals of MNT that apply to individuals at risk for diabetes or with pre-diabetes To decrease the risk of diabetes and cardiovascular disease (CVD) by promoting healthy food choices and physical activity leading to moderate weight loss that is maintained. Goals of MNT that apply to individuals with diabetes

- Achieve and maintain
 - Blood glucose levels in the normal range or as close to normal as is safely possible
 - A lipid and lipoprotein profile that reduces the risk for vascular disease
 - Blood pressure levels in the normal range or as close to normal as is safely possible
- To prevent, or at least slow, the rate of development of the chronic complications of diabetes by modifying nutrient intake and lifestyle
- To address individual nutrition needs, taking into account personal and cultural preferences and willingness to change
- To maintain the pleasure of eating by only limiting food choices when indicated by scientific evidence Goals of MNT that apply to specific situations.

2.1. Effectiveness of nutritional therapy

2.1.1. Recommendations

- Individuals who have pre-diabetes or diabetes should receive individualized MNT; such therapy is best provided by a registered dietitian familiar with the components of diabetes MNT.
- Nutrition counseling should be sensitive to the personal needs, willingness to change, and ability to make changes of the individual with pre-diabetes or diabetes.
- Clinical trials/outcome studies of MNT have reported decreases in HbA1c (A1C) of 1% in type 1 diabetes and 1–2% in type 2 diabetes, depending on the duration of diabetes.”**3-4**”.
- Met analysis of studies in no diabetic, free-living subjects and expert committees report that MNT reduces LDL cholesterol by 15–25 mg/dl. “**5-6**”. After initiation of MNT, improvements were apparent in 3– 6 months. Meta-analysis and expert committees also support a role for lifestyle modification in treating hypertension. “**7-8**”.

2.2. Energy balance, overweight, and obesity

2.2.1. Recommendations

- In overweight and obese insulin resistant individuals, modest weight loss has been shown to improve insulin resistance. Thus, weight loss is recommended for all such individuals who have or are at risk for diabetes.
- For weight loss, either low-carbohydrate or low-fat calorie-restricted diets may be effective in the short term (up to 1 year).
- For patients on low-carbohydrate diets, monitor lipid profiles, renal function, and protein intake (in those with nephropathy), and adjust hypoglycemic therapy as needed.
- Physical activity and behavior modification are important components of weight loss programs and are most helpful in maintenance of weight loss.
- Weight loss medications may be considered in the treatment of overweight and obese individuals with type 2 diabetes and can help achieve a 5–10% weight loss when combined with lifestyle modification.
- Bariatric surgery may be considered for some individuals with type 2 diabetes and BMI 35 kg/m² and can result in marked improvements in glycemia. The long-term benefits and risks of bariatric surgery in individuals with pre-diabetes or diabetes continue to be studied. The importance of controlling body weight in reducing risks related to diabetes is of great importance. Therefore, these nutrition recommendations start by considering energy balance and weight loss strategies. The National Heart, Lung, and Blood Institute guidelines define overweight as BMI 25 kg/m² and obesity as BMI 30 kg/m².”**2- 9**”.

2.3. Nutrition recommendations and interventions for the prevention of diabetes (primary prevention)

2.3.1. Recommendations

- Among individuals at high risk for developing type 2 diabetes, structured programs that emphasize lifestyle changes that include moderate weight loss (7% body weight) and regular physical activity (150 min/week), with dietary strategies including reduced calories and reduced intake of dietary fat, can reduce the risk for developing diabetes and are therefore recommended.

- Individuals at high risk for type 2 diabetes should be encouraged to achieve the U.S. Department of Agriculture (USDA) recommendation for dietary fiber (14 g fiber/1,000 kcal) and foods containing whole grains (one-half of grain intakes).
- There is not sufficient, consistent information to conclude that low-glycemic load diets reduce the risk for diabetes. Nevertheless, low-glycemic index foods that are rich in fiber and other important nutrients are to be encouraged.
- Observational studies report that moderate alcohol intake may reduce the risk for diabetes, but the data do not support recommending alcohol consumption to individuals at risk of diabetes.
- No nutrition recommendation can be made for preventing type 1 diabetes.
- Although there are insufficient data at present to warrant any specific recommendations for prevention of type 2 diabetes in youth, it is reasonable to apply approaches demonstrated to be effective in adults, as long as nutritional needs for normal growth and development are maintained. The importance of preventing type 2 diabetes is highlighted by the substantial 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.”**10**”.

2.4. Nutrition recommendations for the management of diabetes (secondary prevention) Carbohydrate in diabetes management

2.4.1. Recommendations

- Dietary pattern that includes carbohydrate from fruits, vegetables, whole grains, legumes, and low-fat milk is encouraged for good health.
- Monitoring carbohydrate, whether by carbohydrate counting, exchanges, or experienced-based estimation remains a key strategy in achieving glycemic control.
- The use of glycemic index and load may provide a modest additional benefit over that observed when total carbohydrate is considered alone.
- Sucrose-containing foods can be substituted for other carbohydrates in the meal plan or, if added to the meal plan, covered with insulin or other glucose lowering medications. Care should be taken to avoid excess energy intake.
- As for the general population, people with diabetes are encouraged to consume a variety of fiber-containing foods. However, evidence is lacking to recommend a higher fiber intake for people with diabetes than for the population as a whole.
- Sugar alcohols and nonnutritive sweeteners are safe when consumed within the daily intake levels established by the Food and Drug Administration (FDA). Control of blood glucose in an effort to achieve normal or near-normal levels is a primary goal of diabetes management. Food and nutrition interventions that reduce postprandial blood glucose excursions are important in this regard, since dietary carbohydrate is the major determinant of postprandial glucose levels. “**1-2- 11-12-13**”.

Fiber

As for the general population, people with diabetes are encouraged to choose a variety of fiber-containing foods such as legumes, fiber-rich cereals fruits, vegetables, and whole grain products because they provide vitamins, minerals, and other substances important for good health. Moreover, there are data suggesting that consuming a high-fiber diet (50 g fiber/ day) reduces glycemia in subjects with type 1 diabetes and glycemia, hyperinsulinemia, and lipemia in subjects with type 2 diabetes ¹. Palatability, limited food choices, and gastrointestinal side effects are potential barriers to achieving such high-fiber intakes. However, increased fiber intake appears to be desirable for people with diabetes, and a first priority might be to encourage them to achieve the fiber intake goals set for the general population of 14 g/1,000 kcal.

Sweeteners

Substantial evidence from clinical studies demonstrates that dietary sucrose does not increase glycemia more than is caloric 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 can be substituted for other carbohydrate sources in the meal plan or, if added to the 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, and care should be.

Resistant-starch/high-amylase foods

It has been proposed that foods containing resistant starch (starch physically enclosed within intact cell structures as in some legumes, starch granules as in raw potato, and retrograde amylose from plants modified by plant breeding to increase amylose content) or high-amylose foods, such as specially formulated cornstarch, may modify postprandial glycemic response, prevent hypoglycemia, and reduce hyperglycemia. However, there are no published long-term studies in subjects with diabetes to prove benefit from the use of resistant starch.

2.5. Dietary fat and cholesterol in diabetes management Recommendations

- Limit saturated fat to 7% of total calories.
- Intake of trans fat should be minimized.
- In individuals with diabetes, limit dietary cholesterol to 200 mg/day.
- Two or more servings of fish per week (with the exception of commercially fried fish filets) provide n-3 polyunsaturated fatty acids and are recommended.

2.6. Protein in diabetes management Recommendations

- For individuals with diabetes and normal renal function, there is insufficient evidence to suggest that usual protein intake (15–20% of energy) should be modified.
- In individuals with type 2 diabetes, ingested protein can increase insulin response without increasing plasma glucose concentrations. Therefore, protein should not be used to treat acute or prevent nighttime hypoglycemia.
- High-protein diets are not recommended as a method for weight loss at this time. The long-term effects of protein intake 20% of calories on diabetes management and its complications are unknown. Although such diets may produce short-term weight loss and improved glycemia, it has not been established that these benefits are maintained long term, and long-term effects on kidney function for persons with diabetes are unknown.

2.6.1. Optimal mix of macronutrients

Although numerous studies have attempted to identify the optimal mix of macronutrients for the diabetic diet, it is unlikely that one such combination of macronutrients exists. The best mix of carbohydrate, protein, and fat appears to vary depending on individual circumstances. For those individuals seeking guidance as to macronutrient distribution in healthy adults, the Dietary Reference Intakes (DRIs) may be helpful. It must be clearly recognized that regardless of the macronutrient mix, total caloric intake must be appropriate to weight management goals. Further, individualization of the macronutrient composition will depend on the metabolic status of the patient (e.g., lipid profile).¹⁴

2.7. Alcohol in diabetes management Recommendations

- If adults with diabetes choose to use alcohol, daily intake should be limited to a moderate amount (one drink per day or less for women and two drinks per day or less for men).
- To reduce risk of nocturnal hypoglycemia in individuals using insulin or insulin secretagogues, alcohol should be consumed with food.
- In individuals with diabetes, moderate alcohol consumption (when ingested alone) has no acute effect on glucose and insulin concentrations but carbohydrate coingested with alcohol (as in a mixed drink) may raise blood glucose.

Abstinence from alcohol should be 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. If individuals choose to use alcohol, intake should be limited to a moderate amount (less than one drink per day for adult women and less than two drinks per day for adult men). One alcohol containing beverage is defined as 12 oz beer, 5 oz wine, or 1.5 oz distilled spirits. Each contains 15 g alcohol.

2.8. Micronutrients in diabetes management Recommendations

- There is no clear evidence of benefit from vitamin or mineral supplementation in people with diabetes (compared with the general population) who do not have underlying deficiencies.
- Routine supplementation with antioxidants, such as vitamins E and C and carotene, is not advised because of lack of evidence of efficacy and concern related to long-term safety.

- Benefit from chromium supplementation in individuals with diabetes or obesity has not been clearly demonstrated and therefore cannot be recommended.

2.8.1. Chromium, other minerals, and herbs in diabetes management

Chromium, potassium, magnesium, and possibly zinc deficiency may aggravate carbohydrate intolerance. Serum levels can readily detect the need for potassium or magnesium replacement, but detecting deficiency of zinc or chromium is more difficult."15". In the late 1990s, two randomized placebo-controlled studies in China found that chromium supplementation had beneficial effects on glycemia, but the chromium status of the study populations was not evaluated either at baseline or following supplementation. Data from recent small studies indicate that chromium supplementation may have a role in the management of glucose intolerance, gestational diabetes mellitus (GDM), and corticosteroid-induced diabetes."16-17". However, other well-designed studies have failed to demonstrate any significant benefit of chromium supplementation in individuals with impaired glucose intolerance or type 2 diabetes."18-19".

2.9. Nutrition interventions for specific populations

2.9.1. Nutrition interventions for type 1 diabetes Recommendations

- For individuals with type 1 diabetes, insulin therapy should be integrated into an individual's dietary and physical activity pattern.
- Individuals using rapid-acting insulin by injection or an insulin pump should adjust the meal and snack insulin doses based on the carbohydrate content of the meals and snacks. For individuals using fixed daily insulin doses, carbohydrate intake on a day-to-day basis should be kept consistent with respect to time and amount.
- For planned exercise, insulin doses can be adjusted. For unplanned exercise, extra carbohydrate may be needed.

2.9.2. Nutrition interventions for type 2 diabetes Recommendations

- Individuals with type 2 diabetes are encouraged to implement lifestyle modifications that reduce intakes of energy, saturated and trans fatty acids, cholesterol, and sodium and to increase physical activity in an effort to improve glycemia, dyslipidemia, and blood pressure.
- Plasma glucose monitoring can be used to determine whether adjustments in foods and meals will be sufficient to achieve blood glucose goals or if medication(s) needs to be combined with MNT."20".

2.9.3. Nutrition interventions for pregnancy and lactation with diabetes Recommendations

- Adequate energy intake that provides appropriate weight gain is recommended during pregnancy. Weight loss is not recommended; however, for overweight and obese women with GDM, modest energy and carbohydrate restriction may be appropriate.
- Ketonemia from ketoacidosis or starvation ketosis should be avoided.
- MNT for GDM focuses on food choices for appropriate weight gain, normoglycemia, and absence of ketones.
- Because GDM is a risk factor for subsequent type 2 diabetes, after delivery, lifestyle modifications aimed at reducing weight and increasing physical activity are recommended.

2.9.4. Nutrition interventions for older adults with diabetes Recommendations

- Obese older adults with diabetes may benefit from modest energy restriction and an increase in physical activity; energy requirement may be less than for a younger individual of a similar weight.
- A daily multivitamin supplement may be appropriate, especially for those older adults with reduced energy intake."20-21".

2.10. Nutrition recommendations for controlling diabetes complications (tertiary prevention)

2.10.1. Micro vascular complications Recommendations

- Reduction of protein intake to 0.8 –1.0 g kg body wt¹ day¹ in individuals with diabetes and the earlier stages of chronic kidney disease (CKD) and to 0.8 g kg body wt¹ day¹ in the later stages of CKD may improve measures of renal function (urine albumin excretion rate, glomerular filtration rate) and is recommended.
- MNT that favorably affects cardiovascular risk factors may also have a favorable effect on micro vascular complications such as retinopathy and nephropathy. Progression of diabetes complications may be modified by improving glycemic control, lowering blood pressure, and, potentially, reducing protein intake. Normal

protein intake (15–20% of energy) does not appear to be associated with risk of developing diabetic nephropathy (1), but the long-term effect on development of nephropathy of dietary protein intake 20% of energy has not been determined. In several studies of subjects with diabetes and microalbuminuria, urinary albumin excretion rate and decline in glomerular filtration were favorably influenced by reduction of protein intake to 0.8–1.0 g/kg body weight (98–101). Although reduction of protein intake to 0.8 g/kg body weight was prescribed, subjects who were not able to achieve this level of reduction also showed improvements in renal function. "22-23".

2.10.2. Treatment and management of CVD risk Recommendations

- Target A1C is as close to normal as possible without significant hypoglycemia.
- For patients with diabetes at risk for CVD, diets high in fruits, vegetables, whole grains, and nuts may reduce the risk.
- For patients with diabetes and symptomatic heart failure, dietary sodium intake of 2,000 mg/day may reduce symptoms.
- In normotensive and hypertensive individuals, a reduced sodium intake (e.g., 2,300 mg/day) with a diet high in fruits, vegetables, and low-fat dairy products lowers blood pressure.
- In most individuals, a modest amount of weight loss beneficially affects blood pressure.

2.11. Nutrition interventions for acute complications and special considerations for patients with comorbidities in acute and chronic care facilities Hypoglycemia

2.11.1. Recommendations

- Ingestion of 15–20 g glucose is the preferred treatment for hypoglycemia, although any form of carbohydrate that contains glucose may be used.
- The response to treatment of hypoglycemia should be apparent in 10–20 min; however, plasma glucose should be tested again in 60 min, as additional treatment may be necessary. In individuals taking insulin or insulin secretagogues, changes in food intake, physical activity, and medication can contribute to the development of hypoglycemia. Treatment of hypoglycemia (plasma glucose 70 mg/dl) requires ingestion of glucose or glucose-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 oral glucose raises plasma glucose levels by 40 mg/dl over 30 min, while 20 g oral glucose raises plasma glucose levels by 60 mg/dl over 45 min. In each case, glucose levels often begin to fall 60 min after glucose ingestion."24".

2.11.2. Major nutrition recommendations and interventions

Effectiveness of MNT

- Individuals who have pre-diabetes or diabetes should receive individualized MNT; such therapy is best provided by a registered dietitian familiar with the components of diabetes MNT.
- Nutrition counseling should be sensitive to the personal needs, willingness to change, and ability to make changes of the individual with pre-diabetes or diabetes."25".

Energy balance, overweight, and obesity

- In overweight and obese insulin-resistant individuals, modest weight loss has been shown to improve insulin resistance. Thus, weight loss is recommended for all such individuals who have or are at risk for diabetes.
- For weight loss, either low-carbohydrate or low-fat calorie-restricted diets may be effective in the short term (up to 1 year).
- For patients on low-carbohydrate diets, monitor lipid profiles, renal function, and protein intake (in those with nephropathy), and adjust hypoglycemic therapy as needed.
- Physical activity and behavior modification are important components of weight loss programs and are most helpful in maintenance of weight loss. "26".
- Weight loss medications may be considered in the treatment of overweight and obese individuals with type 2 diabetes and can help achieve a 5–10% weight loss when combined with lifestyle modification.
- Bariatric surgery may be considered for some individuals with type 2 diabetes and BMI ≥ 35 kg/m² and can result in marked improvements in glycemia. The long-term benefits and risks of bariatric surgery in individuals with pre-diabetes or diabetes continue to be studied."27".

3. Conclusion

Medical and nutrition experts agree that medical nutrition therapy (MNT) promotes optimal health and prevention of disease progression in chronically ill patients. It is well documented that MNT can improve glycemic control by reducing A1C and, when used with other components of diabetes care, can further improve clinical and metabolic outcomes, resulting in reduced comorbidities and hospitalizations.

Compliance with ethical standards

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