

Guidelines for the Nutritional Management of Diabetes Mellitus in the New Millennium

**A POSITION STATEMENT
BY THE CANADIAN DIABETES ASSOCIATION**

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GUIDELINES FOR THE NUTRITIONAL MANAGEMENT OF DIABETES MELLITUS IN THE NEW MILLENNIUM: A POSITION STATEMENT BY THE CANADIAN DIABETES ASSOCIATION

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INTRODUCTION

The overall goal of diabetes management is to help individuals with diabetes and their families gain the necessary knowledge, life skills, resources and support needed to achieve optimal health. This requires a team effort that includes diabetes health care professionals and the individuals who must deal with this chronic condition on a daily basis. The registered dietitian is a key member of the health care team, who plays an integral role in the individualization of management strategies for people with diabetes and those at risk for developing it. The nutritional management of diabetes follows the principles of *Canada's Food Guide to Healthy Eating* (1) and remains one of the cornerstones of effective therapy.

Nutritional management seeks to improve or maintain the following:

- the quality of life for people with diabetes and their families through management techniques that include the entire family unit in decision-making, while enhancing the individual's personal sense of control and well-being;
- the physiological health of individuals with diabetes, by establishing and maintaining blood glucose and lipid levels as near-normal as possible, and by using vigilance in preventing and/or treating diabetes-related complications and any concomitant conditions; and
- the nutritional status of people with diabetes, by recognizing that their micro- and macronutrient requirements are similar to those of the general population.

General principles

In general, nutrition advice for people with diabetes is the same as that for all Canadians, and follows the principles of *Canada's Guidelines for Healthy Eating* (2):

- Enjoy a variety of foods.
- Emphasize cereals, breads and other whole grain products, vegetables and fruits.
- Choose lower-fat dairy products, leaner meats and foods prepared with little or no fat.
- Achieve and maintain a healthy body weight by enjoying regular physical activity and healthy eating.
- Limit salt, alcohol and caffeine.

People with diabetes can continue to enjoy the foods they love, in moderation, while maintaining the variety promoted by *Canada's Food Guide to Healthy Eating*. If medication is necessary to optimize diabetes control, its use should be an adjunct to regular physical activity and healthy eating. The timing and doses of medication used should be adjusted to fit with the eating and physical activity patterns chosen by the individual with diabetes.

Nutritional goals of diabetes management

A major goal for diabetes care is to improve glycemic control by balancing food intake with endogenous and/or exogenous insulin levels. For people with type 1 diabetes, insulin doses need to be adjusted to balance with nutritionally adequate food intake and physical activity. For individuals with type 2 diabetes, impaired glucose tolerance or impaired fasting glucose, attention to food portions and weight management combined with physical activity may help improve glycemic control. Nutrition and all forms of diabetes management should be individualized.

Recommendations

- All people with diabetes should receive nutritional counselling from a registered dietitian.
- *Canada's Guidelines for Healthy Eating* and *Canada's Food Guide to Healthy Eating* should be equally applied to people with diabetes and without diabetes.
- People with diabetes should be encouraged to obtain optimal metabolic control through a balance of food intake, physical activity and medication (if required) to avoid complications (3,4).
- Specific dietary recommendations and medications should be individualized to accommodate the person's preferences and lifestyle.

ENERGY NUTRIENTS

Carbohydrates

Dietary carbohydrates from cereals, breads, other grain products, legumes, vegetables, fruits, dairy products and added sugars should provide 50–60% of the individual's energy requirements (5). Both the source and the amount of carbohydrate consumed influence blood glucose and insulin responses (6,7). The terms "simple" and "complex"

should not be used to classify carbohydrates, because they do not help to determine the impact of carbohydrates on blood glucose levels (8,9). Factors that influence blood glucose are not predicted by chemical composition alone; food form, ingested particle size, starch structure and cooking methods may all influence the carbohydrate absorption rate from the small intestine and the resultant blood glucose response (10).

The glycemic index (GI) expresses the rise in blood glucose elicited by a carbohydrate food as a percentage of the rise in blood glucose that would occur if the same individual ingested an equal amount of carbohydrate from white bread or glucose (8,11). Increased use of low GI foods such as legumes, barley, pasta and whole intact grains (e.g. cracked wheat) may help improve blood glucose control and allow carbohydrate intake to be increased without raising serum triglycerides (12).

The role of the GI in diabetes therapy is controversial. The GI is not endorsed by the American Diabetes Association (13), but it is recommended by the Diabetes Nutrition Study Group of the European Association for the Study of Diabetes (14) and by the World Health Organization (8). There is concern that including GI information in nutrition teaching is too complicated and limits food choices (15). Nevertheless, in people with newly diagnosed type 2 diabetes, there is evidence that nutrition education based on the GI is associated with higher carbohydrate, lower fat and higher fibre intakes — as well as better blood glucose and lipid control — compared to those educated using traditional dietary advice (16). Epidemiological studies also suggest that use of low GI foods reduces the risk of developing type 2 diabetes (17,18). Extensive tables of the GI values of foods have been published (19).

Recommendations

- Carbohydrates should provide 50–60% of daily energy requirements.
- The amount and source of carbohydrate in meal planning should be considered.
- Including low GI foods may be helpful in optimizing blood glucose control.

Sugars

In the past, avoidance of sugar has been a major focus of nutritional advice for people with diabetes. However, research clearly shows that sugars are an acceptable part of a healthy diet for those with diabetes, particularly sugars obtained from fruits, vegetables and dairy products. Up to 10% of total daily energy requirements may consist of added sugars, such as table sugar and sugar-sweetened products, without impairing glycemic control in people with type 1 (20) or type 2 (21,22) diabetes.

Foods containing sugars vary in nutritional value and physiological effects. For example, sucrose and orange juice have similar effects on blood glucose but contain different amounts of vitamins and minerals. Consuming whole fruits and fruit juices causes blood glucose concentrations to peak

slightly earlier but fall more quickly than consuming an equivalent carbohydrate portion of white bread. This results in a lower GI for fruits and fruit juices than bread (9,23). Because refined sucrose produces a lower blood glucose response than many refined starches, some sweetened breakfast cereals produce lower plasma glucose and insulin responses than equal carbohydrate portions of unsweetened cereals (24). Thus, undue avoidance of foods containing simple sugars is not necessary. Generally, however, intake of added fructose, sucrose or high-fructose corn syrup in excess of 10% of energy should be avoided, since evidence suggests that this may increase serum triglycerides and/or LDL cholesterol in susceptible individuals (25).

Recommendations

- Naturally occurring and added sugars should be included as part of the daily carbohydrate allowance and as part of a healthy eating plan.
- Most people with diabetes can include added sugars up to 10% of daily energy requirements without deleterious effects on blood glucose or lipid control.

Fibre

Daily soluble fibre intake of 5–10 g/d from oats, barley, legumes or purified fibre sources such as psyllium, pectin and guar, can reduce serum cholesterol by 5–10% (26,27). Purified soluble fibre sources reduce blood glucose responses and have been associated with improved blood glucose control (28). However, soluble fibre content alone is not a reliable indicator of the food's metabolic effects. Research indicates that the insoluble fibre content of whole foods is more closely related to their GI than the soluble fibre content (29). This is consistent with data from epidemiological studies, which suggest that insoluble fibres from cereals may reduce the risk for coronary heart disease and type 2 diabetes by up to 30% for each 10 g increment in intake (17,18,30). All Canadians, including people with diabetes, are advised to increase fibre intake from a variety of foods by following *Canada's Food Guide to Healthy Eating*.

Recommendations

- Total dietary fibre intake of at least 25–35 g/d from a variety of sources, as recommended by *Canada's Food Guide to Healthy Eating*, is advised for adults. For children, 5 g plus 1 g/year of age is suggested as a guide.
- Including more foods and food combinations that combine cereal fibre with low GI may be helpful in optimizing health outcomes for people with diabetes or at risk for diabetes.

Protein

Current evidence indicates people with diabetes have similar protein requirements to those of the general population — about 0.86 g/kg per day (5). Although protein plays a role in stimulating insulin secretion (31,32), excessive intake should be avoided as it may contribute to the pathogenesis of diabetic nephropathy (33). Some evidence suggests eating vegetable protein rather than animal

protein is better for reducing serum cholesterol (34) and managing nephropathy (35,36).

Recommendations

- Protein intake should be at least 0.86 g/kg/day.
- Vegetable protein should be considered as an alternative to animal protein.

Fats

Numerous studies indicate high-fat diets can impair glucose tolerance and promote obesity, dyslipidemia and atherosclerotic heart disease. Research also shows these same metabolic abnormalities are reversed or improved by reducing saturated fat intake. Current recommendations on fat intake for the general population apply equally to people with diabetes: reduce saturated fats to 10% or less of total energy intake and cholesterol intake to 300 mg/d or less (37). Scientific debate continues over which alternative is preferable to saturated fat — polyunsaturated fat, monounsaturated fat or carbohydrate calories (38,39).

Health Canada's nutrition guidelines are still considered appropriate for most people with diabetes. For adults who have normal lipid levels and maintain a reasonable weight, the guidelines recommend a daily fat intake $\leq 30\%$ of daily energy requirements, comprised of $\leq 10\%$ saturated fat and $\leq 10\%$ polyunsaturated fat, with the remainder coming from monounsaturated fat (5).

Research suggests monounsaturated fat (such as canola, olive and peanut oils) may have beneficial effects on triglycerides and glycemic control in some individuals with diabetes (40), but care must be taken to avoid weight gain. Omega-3 fatty acids, found in fish such as salmon and mackerel, may reduce serum triglycerides without impairing glycemic control (41). Although consuming large quantities of omega-3 fatty acids from natural foods is probably not practical for most, eating fish rich in omega-3 fatty acids at least once weekly is recommended. Conversely, ingesting trans-fatty acids that are commonly found in many manufactured foods should be limited. Produced by hydrogenating vegetable oils, the biological effects of trans-fatty acids are similar to those of saturated fat (42,43).

Recommendations

- Total fat should be limited to $\leq 30\%$ of daily energy requirements.
- Saturated and polyunsaturated fats should each provide $\leq 10\%$ of daily energy requirements.
- Monounsaturated fats should be used where possible.
- Use of processed foods containing saturated fats and trans-fatty acids should be limited.
- Fish rich in omega-3 fatty acids should be recommended at least once weekly.

Alcohol

Moderate alcohol consumption is acceptable for individuals with diabetes whose blood glucose and lipids

are well controlled. Intake should account for no more than 5% of total energy intake or 2 drinks per day, whichever is less. Abstinence is recommended during pregnancy and lactation. Restriction or avoidance of alcohol may also be advisable for people with concomitant medical conditions such as dyslipidemia, hypertension or liver impairment. Regular alcohol intake can contribute to weight gain and both hypoglycemia and hyperglycemia. Guidelines on the use of alcohol should be included as part of meal-planning discussions.

Alcohol impairs hepatic glucose release and can cause delayed hypoglycemia in individuals taking insulin and/or insulin secretagogues. Increased physical activity and/or reduced food intake in the presence of alcohol intake can further increase the risk of hypoglycemia. To reduce this risk, individuals on these medications would be advised to consume foods containing carbohydrate when drinking alcohol. Family members and other support people should understand the relationship between alcohol and diabetes and how to manage short-term consequences. People with diabetes should be encouraged to wear medical alert bracelets, to ensure prompt identification and treatment of their condition in emergency situations.

Recommendations

- People with diabetes should discuss alcohol use with their health care team.
- Alcohol consumption should be limited to 5% of total energy intake or 2 drinks per day, whichever is less.
- People with diabetes using insulin and/or insulin secretagogues, should eat a carbohydrate food when drinking alcohol to help avoid hypoglycemia.
- Abstinence from alcohol is advised during pregnancy and lactation.
- Individuals with medical conditions such as dyslipidemia, hypertension or liver impairment should avoid or restrict alcohol consumption.

Sweeteners

Moderate use of nutritive (sucrose, fructose, the sugar alcohols [xylitol, mannitol, sorbitol, isomalt, lactitol and maltitol] and aspartame) and non-nutritive sweeteners (acesulfame potassium, sucralose, cyclamate and saccharin) can be part of a well-balanced diet for people with diabetes (44). The energy and/or carbohydrate content of nutritive sweeteners needs to be included in the meal plan, whereas non-nutritive sweeteners do not affect blood glucose levels and provide little or no energy. For example, aspartame is a nutritive sweetener. It provides 16 kJ/g but has a minimal energy contribution to the diet because it is extremely sweet (180–200 times sweeter than sucrose), so only a very small amount is required to sweeten a food product. Sugar alcohols raise blood glucose only minimally (45,46) and contribute a small amount of energy to the diet. Sugar alcohols are absorbed and metabolized at different rates in the small intestine and can cause flatulence and diarrhea in some individuals (47).

During pregnancy and lactation, saccharin and cyclamate

are not recommended. In moderation, acesulfame potassium, aspartame and sucralose (48) are acceptable. In individuals with phenylketonuria, the use of aspartame is contraindicated.

In Canada, nutritive and non-nutritive sweeteners are regulated as food additives. Health Canada sets standards that regulate the amount of food additives that are permitted for use in foods. Table 1 provides the acceptable daily intake (ADI) for some common sweeteners. The ADI is expressed in mg/kg of body weight per day and is defined as the amount of sweetener that can be safely consumed on a daily basis over a person's lifetime without any adverse effects. The ADI amounts are actually much higher than the amounts an individual would consume in a typical diet. However, individuals with diabetes should receive individualized counselling on how to include the use of foods containing sweeteners. These foods are often not low in energy due to the fat content of the product. Individuals should therefore be advised on how to evaluate food labels for total fat and sweetener content and on how to substitute these products for other food choices within the meal plan. Individuals should also monitor blood glucose and lipid levels on a regular basis and assess their response to routine sweetener use.

Recommendations

- Individuals with diabetes should be educated on the appropriate use of nutritive and non-nutritive sweeteners.
- The impact of nutritive sweeteners on the individual's blood glucose levels and lipid profiles should be assessed on a regular basis.

MICRONUTRIENTS

People with diabetes should be encouraged to obtain daily vitamin and mineral requirements from a well-balanced diet. Routine use of vitamin/mineral supplements is not recommended except in cases of inadequate food consumption or other special needs. Despite various claims concerning the benefits of supplements of vitamins and minerals in the treatment of diabetes, the evidence is not sufficient at this time to recommend routine supplementation.

People with diabetes have reduced antioxidant capacity, and this may play a role in the development of complications by increasing protein glycosylation, increasing the atherogenic potential of serum LDL particles and altering endothelial function (49). Short-term increases in plasma antioxidant capacity can be demonstrated after consumption of antioxidant vitamins such as β -carotene or vitamins C or E. However, the long-term implications of this are not clear. The Microalbuminuria, Cardiovascular and Renal Outcomes of the Heart Outcomes Prevention Evaluation (MICRO-HOPE) study involves 3,657 subjects with diabetes randomized to receive ACE inhibitor or placebo and vitamin E or placebo for 4 years (50). The results of this study, expected next year, will be helpful in determining the role of vitamin E in the treatment of diabetes.

Table 1

Sweeteners

Acceptable daily intake (mg/kg body weight/day)

Aspartame	40	Saccharin	5
Acesulfame K	15	Sucralose*	15
Cyclamate	11		

*Canada has a more conservative ADI of 9 mg/kg body weight/day
Ref.: 1996 FAO/WHO Joint Expert Committee Food Additives publication.

Decreased magnesium stores are correlated with poor diabetic control, insulin resistance, macrovascular disease and hypertension (51), but the low magnesium status may be the result rather than the cause of these conditions. There is insufficient evidence that magnesium supplements improve blood glucose control. Chromium deficiency can result in decreased glucose tolerance but is believed to be rare (52). Most studies have not shown any benefit from chromium supplements, possibly because of inadequate doses or the use of poorly absorbed forms of the mineral (53). A recent study showed that chromium picolinate significantly improved glycemic control in people with diabetes (54). However, the doses used, 3.84 and 19.2 μ mol (200 and 1,000 μ g of elemental chromium) per day, were higher than the upper limit of the estimated safe and adequate daily intake.

Recommendations

- People with diabetes should be encouraged to obtain daily vitamin and mineral requirements from a well-balanced diet.
- Routine use of vitamin or mineral supplements is not recommended except in cases of inadequate food consumption or other special needs.

LIFE STAGES

Infants, children and teenagers

Adequate nutrition should be provided to support the growth, development and normal activity of all children with diabetes. Protein requirements for children with diabetes are higher than those of adults but are no different than for children without diabetes (5). Fat restriction ($\leq 30\%$ total energy) is contraindicated in infants and young children less than 2 years of age (55). Avoiding hypoglycemia is the primary goal of diabetes management in this population (56). Variable carbohydrate intake in this group can make it difficult to predict insulin doses. Fast-acting insulin analogues can be useful in this situation since they may be given after meals based on the amount of carbohydrate eaten. Meals and snacks should be planned around the child's individual routine, and frequent follow-up is recommended so the nutritional plan can be adjusted to meet the growing child's energy needs.

Most children with type 1 diabetes have normal lipid levels and acceptable weights but are at significant risk of developing long-term macrovascular disease (57). This risk is increased by adoption of lifestyle factors such as excess energy intake, diets high in saturated fats, low physical activity and smoking. Lifestyle education and counselling on avoiding these risks can prevent or delay the development of cardiovascular disease later in life. There has been an increase in the diagnoses of children with type 2 diabetes, especially in ethnic populations in Canada. Diabetes resources should be made available to families with children who have type 1 or type 2 diabetes. Bridging programs should be implemented to facilitate the transition from adolescence to adulthood.

Weight gain following initiation of insulin therapy and focus on dietary restraint may lead to body-image dissatisfaction and weight concerns already common in adolescence, therefore predisposing a child to disordered eating (58–61). Clinical warning signs to identify individuals at risk of eating disorders include refractory metabolic control, weight occupation and anxiety about being weighed, and delay in puberty, sexual maturation or growth (58,62–66). It is recommended that screening for behaviours/attitudes associated with disordered eating (i.e. excessive physical activity, restrictive eating, insulin misuse and body-image dissatisfaction) be incorporated into follow-up visits (58,61,64,67–69).

Recommendations

- Avoiding hypoglycemia should be the primary goal of diabetes management in infants and children.
- All children should be assessed at least annually by a registered dietitian specializing in pediatric nutrition to ensure they are receiving adequate nutrition for growth and development.
- Parents and caregivers of children with diabetes should be alert for unpredictable carbohydrate intake that may require adjustment to the type, timing and dose of insulin.
- Fat restriction is contraindicated in infants and young children less than 2 years of age.
- Lifestyle and smoking avoidance education are recommended to reduce the long-term risks of vascular disease.
- Follow-up visits should incorporate routine screening for behaviours and attitudes associated with disordered eating.
- Bridging programs should be used to assist transitions from adolescence to adulthood.

Pregnancy

Achieving normoglycemia while consuming a nutritionally adequate diet is the goal for women who enter pregnancy with pre-existing diabetes and for those who develop diabetes while pregnant. Preconception counselling is recommended to promote these goals and to initiate a multivitamin supplement that contains 0.4 mg to

1.0 mg of folic acid. This supplement is recommended before pregnancy and during the early weeks of pregnancy to ensure that folic acid requirements are met (70). Control of blood glucose and supplementation of folic acid are both promoted to reduce the risk of congenital malformations in the offspring of women with type 1 and 2 diabetes. Screening of all pregnant women (except those at very low risk) at 24–28 weeks is recommended to diagnose and treat gestational diabetes mellitus (71).

It is important that the woman with diabetes have follow-up visits with a health care team experienced in prenatal care. A registered dietitian's role is to promote a healthy diet that meets the micro- and macronutrient needs of pregnancy. Food choices are often divided into 6 small meals spread at regular intervals throughout the day and evening. This small, frequent meal pattern may help reduce prenatal complaints such as nausea and heartburn while reducing the risk of hypoglycemia and ketonuria. This strategy appears to reduce acute peak glycemia excursions (72,73), which may avoid the need for adjustments to insulin dosage. However, more research is required to establish whether increasing meal frequency reliably improves overall glycemic control in diabetes or alters pregnancy outcome. Tools such as daily food/activity records, morning ketone testing, daily self blood glucose monitoring and regular weight gain monitoring will help the registered dietitian further individualize the nutrition care plan with the expectant mother. Pregnancy-specific issues such as the safety of medications, use of nutritive and non-nutritive sweeteners, treatment of nausea and appropriate physical activity should be discussed on an individual basis. Insulin requirements increase in pregnancy and may require that adjustments be made to insulin dosage. The use of insulin secretagogues in pregnancy is contraindicated (74,75). Breastfeeding should be promoted during pregnancy; women with diabetes need to understand that they can successfully breastfeed their offspring and that they are aware of resources available to them.

During the early weeks of the postpartum period, mothers with diabetes should continue to check their blood glucose regularly. It is important that women with gestational diabetes understand that they are at risk of developing subsequent diabetes and that they should be tested again between 6 weeks and 6 months postpartum. Lifestyle issues such as healthy eating habits and regular physical activity to achieve a healthy body weight should be encouraged. For breastfeeding women, ensure that energy requirements are met. Breastfeeding women requiring insulin may need to adjust their dose based on self blood glucose monitoring results (76). It is important to protect the infant from the risk of maternal hypoglycemia by ensuring that food is handy to treat low blood glucose. Hypoglycemia is often related to a late meal or snack rather than due to the energy expended by the feeding (76). As the infant is weaned off breast milk, women with diabetes will have to continue to monitor their weight, energy intake, medication and blood glucose levels to achieve goals set with the health care team.

Recommendations

- All mothers with diabetes should have follow-up visits with a registered dietitian to ensure that the diet is well-balanced and individualized with the goal of achieving normal maternal glucose levels.
- A multivitamin with 0.4 mg to 1.0 mg folic acid prior to conception and during the early weeks of pregnancy is recommended to reduce the risk of neural tube defects and congenital malformations in the offspring of the mother with diabetes.
- Breastfeeding should be promoted prenatally to ensure that women with diabetes know how to deal with the glycemic effects of breastfeeding.
- Women with gestational diabetes should be informed of their increased risk for type 2 diabetes and the importance of adopting a healthy lifestyle.

Elderly

Nutrition management for older persons with diabetes is essentially the same as for older adults without diabetes. When developing a meal plan, it is important to consider the presence of co-existing conditions and the individual's social situation, including finances and the ability to shop and cook. Hypoglycemia is a serious concern among older people with diabetes who take insulin and/or insulin secretagogues for their diabetes, since many have reduced awareness of symptoms (77). Meal planning should therefore consider the risk of hypoglycemia in older persons taking diabetes medication. Because of a reduced thirst mechanism in the older person, adequate fluid intake must be ensured to avoid dehydration and constipation. Dietary approaches to prevent constipation in the older person with diabetes are encouraged. Pharmaceutical and physical interventions to treat constipation should be used as a last resort. Regular follow-up visits to the health care team can help promote adequate energy, protein and micronutrients in their diet, while maintaining a good quality of life.

Recommendations

- Nutrition plans for older persons with diabetes should be the same as for other adults with diabetes but may need adjustment due to co-existing conditions and social situation.
- Meal planning should consider the risk of hypoglycemia in individuals on insulin and/or insulin secretagogues.
- Dietary approaches for the treatment of constipation should be attempted in older persons with diabetes.
- Periodic nutritional assessments are advised to ensure adequate intake of energy, protein, micronutrients and maintenance of quality of life.

LIFESTYLE/CULTURE

Frequency of eating

There is evidence that dividing carbohydrate portions into 9 or more equal meals spaced throughout the day reduces serum cholesterol (78) and will acutely reduce the

peak glycemic excursions that can occur by ingesting carbohydrate in 3 large meals spaced 4–5 hours apart (79). This strategy may be useful in certain circumstances, such as gestational diabetes. However, there is no evidence that increased meal frequency (changing from 3 to 9 meals per day) leads to long-term improvement in glycemic control (80). The consumption of small, equal-sized, frequent meals, with no increase in energy intake, may be difficult to achieve in the long term because the size and timing of meals is determined by a multitude of chronobiological, physiological, psychological, social and cultural factors (81). Consequently, there is no one ideal food distribution pattern that can be universally recommended.

Recommendation

- The person with diabetes and the health care team should determine appropriate meal intervals.

Exercise

The multiple health benefits and improved sense of well-being that physical activity provides are well known (82,83). For people with type 2 diabetes, increasing physical activity can also increase insulin sensitivity, thereby improving glycemic control. This may lessen or eliminate the need for medication (82). People with type 1 diabetes can also enjoy the benefits of physical activity, although the effect on glycemic control will vary among individuals (83).

Physical activity can also benefit the person with diabetes by aiding in weight loss. Weight loss in itself can often decrease blood glucose. However, regardless of weight loss, physical activity may require the adjustment of insulin and/or insulin secretagogues as well as carbohydrate intake depending on the person's weight goal and personal choice. For example, for people attempting weight loss by initiating or increasing physical activity, diabetes medications may need to be decreased to avoid hypoglycemia, since increasing food intake would be counter-productive. Those requiring diabetes medications must also be aware that the glucose-lowering effects of physical activity can last or occur up to 12–24 hours or more after the activity. Thus, medications and/or food intake may need to be adjusted after physical activity, not just before it. Frequent blood glucose monitoring should aid any adjustments.

Individual tolerance of physical activity, concomitant physical or medical conditions and diabetes control should be assessed prior to the health care team recommending an appropriate program of physical activity (84). *Canada's Physical Activity Guide to Healthy Active Living* (85) can serve as a reference for those with uncomplicated diabetes and no other medical conditions.

Recommendations

- People with diabetes should consult with the diabetes health care team when considering a change to their level of physical activity.
- Plans for physical activity should be individualized for all people with diabetes.

- Medication and/or food may need to be adjusted to avoid hypoglycemia while meeting individual body weight goals.

Vegetarian eating

A well-balanced vegetarian diet can be a healthy choice for people with diabetes. Vegetarian diets emphasize fibre-rich grains and vegetable proteins, both of which have been associated with lowering cholesterol levels and cardiovascular risk (86–88). Nutritional evaluations of protein, iron, calcium, vitamin B12, vitamin D and overall daily energy intake are recommended. Special attention is needed in planning vegan diets for children, older adults, pregnant or lactating women, and ill people with diabetes (89,90). A registered dietitian can assist these groups in the planning of nutritionally adequate meals.

Recommendations

- A well-balanced vegetarian diet can be considered as a healthy choice for people with diabetes.
- A registered dietitian should be consulted to help plan nutritionally adequate meals, especially in children, older adults, pregnant or lactating women, and ill people with diabetes.

Travel

Many people with diabetes experience difficulty managing their diabetes when travelling. Individuals who use insulin and/or insulin secretagogues may have increased hypoglycemia and hyperglycemia while travelling due to several factors including the following: time changes, lack of or abundance of food, restaurant eating and lack of physical activity or excess of unplanned physical activity. These individuals should be made aware of the possible hypoglycemia and hyperglycemia that may result, and strategies to prevent this should be discussed.

Since meals on trains and planes may not meet dietary needs, the individual using insulin and/or insulin secretagogues should be prepared to prevent and treat hypoglycemia. Extra carbohydrate foods need to be carried with the individual to supplement the diet if meals are inadequate or delayed. Airlines often provide special meals for people with diabetes; however, in practice these meals tend to be low in carbohydrate.

Counselling on insulin and/or insulin secretagogue adjustments for travel across time zones should be individualized (91,92).

Recommendations

- Education should be provided about strategies to prevent hypoglycemia and hyperglycemia while travelling.
- The person with diabetes should have carbohydrate foods available to prevent or treat hypoglycemia.
- Counselling on insulin and/or insulin secretagogue adjustments when travelling across time zones should be individualized.

Cultural sensitivity

When conducting nutritional assessments and providing nutritional advice, the registered dietitian takes into account many variables in the hope of positively influencing behaviour and health outcomes. In addition to health beliefs, decision-making skills, financial resources, food availability and personal choice, foods chosen by people with diabetes are often influenced by their cultural heritage. To facilitate adherence, knowledge of culturally and individually acceptable foods will assist the registered dietitian in planning meals with the individual with diabetes (93,94).

Special attention must be provided to Aboriginal people, because type 2 diabetes is now recognized as a major health problem in this population. Over the past 50 years, dramatic changes in lifestyle in Aboriginal communities across North America have affected the social, environmental and health status of this population (71). Aboriginal diets vary greatly throughout the country. Aboriginal people in remote northern communities have vastly different lifestyles than those living in urban centres. In general, there is more consumption of supermarket foods and less reliance on once-traditional foods (95). Many Aboriginal health authorities believe that the use of non-traditional foods and the prevalence of sedentary lifestyles may be contributing to the rising incidence of type 2 diabetes among Aboriginal people. Thus, a return to a traditional diet is encouraged, provided the foods selected are safe, acceptable and accessible to the individual. A return to traditional activity levels may also be useful in achieving positive health outcomes (96–98).

Acquisition of an understanding of the Aboriginal ethno-specific communication patterns and an understanding of the learning styles of Aboriginal people are important in nutritional assessments and in providing nutritional advice. Incorporating these into the diabetes education provided may remove barriers to effective meal planning and health care (99,100).

Recommendations

- Culturally specific food practices and preferences of people with diabetes should be considered in meal planning.
- Returning to a traditional diet (provided the foods are safe, acceptable and accessible) and returning to traditional activity levels should be considered for Aboriginal people in achieving positive health outcomes.
- Diabetes education should include understanding the communication patterns and learning styles of Aboriginal people to facilitate effective meal planning and health care.

OTHER CONSIDERATIONS

Weight management and obesity

“Overweight” is currently defined as a body mass index ($BMI = wt\ (kg)/ht\ (m)^2$) of 25.0–29.9 kg/m^2 , with “obesity” defined as a $BMI \geq 30.0\ kg/m^2$ (101). In addition to BMI, measurement of waist circumference is recommended as a simple means of assessing obesity

independent of height, and may be more meaningful to people with diabetes than their BMI (101). For adults with a BMI of 25.0–34.9 kg/m², a waist circumference ≥ 102 cm (40 inches) in men and ≥ 88 cm (35 inches) in women is a sign of excess abdominal fat, which is associated with an increased risk of metabolic complications (102). The prevalence of obesity has doubled over the last 20 years in Canada, and there is an alarming increase in the number of overweight and obese children. In developed countries like Canada, there is a gradual rise in body weight and increase in percent body fat with age at least until 60–65 years of age (101).

About 80% of people with type 2 diabetes are overweight. Indeed, most cases of type 2 diabetes might be prevented or delayed by early and effective weight management. In addition to increased diabetes and cardiovascular risk factors, people with a large waist circumference frequently experience more breathlessness, back pain and difficulties in walking, shopping, climbing stairs, bending over, bathing and dressing (103). Many symptoms experienced by overweight people with diabetes may be related more to excess body weight than poor glycemic control. Weight management improves all aspects of diabetes control, including blood glucose, blood lipids and hypertension. However, attainment of desirable body weight is not always necessary to achieve good metabolic control, which is the primary aim of diabetes therapy.

Weight management is best achieved by strategies that promote gradual rather than quick weight loss. Very-low-calorie diets are known to produce short-term benefits that disappear over the long term (104,105). Weight management in obesity should focus on adopting a healthy lifestyle through food choices and regular physical activity. Reducing energy intake by restricting dietary fat is considered a better nutritional strategy for achieving weight loss in people with diabetes than a general restriction of energy (106) and may also reduce the risks of heart disease and some forms of cancer. *Canada's Physical Activity Guide to Healthy Active Living* recommends 60 minutes of physical activity every day. For moderate activities such as brisk walking, the goal is 30–60 minutes per day. The physical activity can be spread throughout the day, with several bouts of activity lasting 10 minutes each being just as effective as a single bout lasting 20–30 minutes. Individuals with a sedentary lifestyle may not be fit enough to achieve immediately the recommended amount of physical activity on a daily basis. Thus, a gradual increase in the intensity, duration and frequency of physical activity should be recommended over a period of weeks or months on an individual basis. Follow-up visits with the health care team are important in assessing adjustments that may be required as a result of the individual's weight management routine.

Recommendations

- Healthy weight gain in childhood and throughout adult life should be a goal for people with diabetes.
- When appropriate, gradual weight loss of 0.25–1.0 kg (0.5–2.0 lbs) per week should be advised with an

achievable, time-limited target such as 7 kg over 3 months.

- Weight loss of 5–10% of initial weight should be sufficient to result in significant improvement in glycemic control and other co-morbidities.
- The health care team should be consulted, as a downward adjustment of insulin and/or insulin secretagogue doses may be necessary as a person with diabetes loses weight.
- If weight loss is not possible, prevention of further weight gain should be attempted.
- Weight loss is best achieved with a combination of increased physical activity and reduced energy intake. Sixty minutes of physical activity daily and a diet containing $\leq 30\%$ energy from fat including a variety of foods such as whole fruits and vegetables and appropriately refined whole grain products are recommended for long-term weight management.
- Screening for and management of risk factors associated with obesity, such as dyslipidemia, hypertension and hyperglycemia are recommended.

Hypertension

Controlling hypertension in people with type 2 diabetes reduces the risk of diabetes-related deaths, diabetes complications, progression of diabetic retinopathy and deterioration in visual acuity (107). In those with diabetes, hypertension (i.e. blood pressure $\geq 140/90$ mm Hg) should be treated to attain target blood pressure $< 130/85$ mm Hg (71). Non-pharmacological treatment of hypertension in most people with diabetes is the same as for those without diabetes (108). Often this is part of a general strategy to attain healthy weight through balanced eating and regular activity (109,110). A sodium restriction of 2–4 g/d may benefit those who are salt-sensitive (111). Avoidance or restriction of alcohol intake and smoking cessation may also be beneficial. Pharmacological therapy is indicated when lifestyle interventions are unsuccessful in controlling hypertension (71).

Recommendations

- People with diabetes should be encouraged to achieve and maintain target blood pressure through balanced eating, regular activity, weight management and smoking cessation.
- Sodium and alcohol restriction should be encouraged and may be beneficial.
- Antihypertensive medications are recommended if lifestyle interventions are unsuccessful in managing hypertension.

Dyslipidemia

People with diabetes have a two- to threefold increase in mortality due to cardiovascular disease (112). Therefore, these individuals should aim to achieve and maintain target lipid levels, as defined in the Clinical Practice Guidelines (71). Dyslipidemia is often a characteristic of poor glycemic control. Consequently, the first approach in managing

dyslipidemia is to improve blood glucose levels through dietary modifications, regular physical activity and, if necessary, adjustments of diabetes medications (71). Better glycemic control often improves but does not always optimize lipid levels. The nutritional approaches used to manage dyslipidemia in individuals with diabetes are essentially the same as for those who do not have diabetes. If LDL cholesterol and triglycerides remain suboptimal after attempts to improve glycemic control and modify fat intake, lipid-lowering agents may be introduced.

Recommendations

- Glycemic control should be improved as a first approach in managing dyslipidemia.
- General nutrition management of dyslipidemia in individuals with diabetes should be the same as for those without diabetes.
- If necessary, lipid-lowering agents to control LDL cholesterol and triglycerides should be introduced.

Nephropathy

Persons with diabetes are several times more prone to kidney disease than the general population. Consequently, nutritional recommendations in people with diabetes and renal disease depend on the degree of nephropathy and concurrent treatments such as dialysis and transplantation. Limiting protein intake to no more than requirements (0.86 g/kg/d for adults) is considered sufficiently restrictive to manage diabetic nephropathy at all stages of the disease (113). Restricting protein intake to less than requirements has no additional benefit on the progression of renal disease and may result in inadequate intake of essential amino acids. However, there is some evidence that the use of non-meat protein sources may be preferable to animal protein sources in the management of renal disease. Non-meat protein sources reduce glomerular filtration (114) and are associated with lower protein and phosphate intakes (115) and beneficial effects on blood pressure, body weight and blood lipids (116). People with diabetes can be encouraged to include vegetable protein sources in their meal plans, with attention to the use of complementary protein sources (e.g. combining legumes or peanuts with grains) to ensure high protein quality. Further research is needed before more definitive recommendations can be made. Restriction of sodium, potassium and phosphorus intakes should be considered on an individual basis based on the results of laboratory tests.

Recommendations

- Diabetic nephropathy should be managed by limiting protein intake to 0.86 g/kg/day in adults. For children, protein intake should be limited to the recommended nutrient intake (RNI) for age and gender.
- Some animal protein should be substituted with high-quality non-meat protein sources.
- Sodium, potassium and phosphorus restriction should be individualized.

Neuropathy

Gastroparesis is a form of diabetic neuropathy that can affect the digestion of food and retard glucose absorption. Gastropathy is a broader term used to describe various disorders of upper gastrointestinal motility that are prevalent in diabetes. Gastropathy can result in postprandial hypoglycemia that is later followed by higher than normal blood glucose rises. Symptoms of gastropathy can include early satiety, decreased appetite, bloating, abdominal discomfort, nausea, vomiting and unexplained hypo/hyperglycemia. These symptoms may subside with improved blood glucose control. Dietary strategies that may prove useful in the treatment of gastropathy include the following: chewing food thoroughly; having small, frequent, low-fat meals; increasing the intake of foods of higher liquid consistency; eating solids as tolerated; and maintaining a low-fibre diet to discourage the development of bezoars. Nutritional supplements, multivitamin/minerals and in some cases enteral or parenteral feedings may be necessary to meet nutritional requirements. Gastropathy may also be managed with various pharmacological agents. Gastropathy in people with diabetes can vary widely in severity and can severely complicate diabetes management. Each case must be approached individually; blood glucose monitoring is recommended to assist in the appropriate adjustment to medication if required (117).

Recommendations

- Dietary strategies to manage gastropathy should be individualized and may include the following: chewing food thoroughly; having small, frequent low-fat meals; increasing intake of foods of higher liquid consistency; eating solids as tolerated; and maintaining a low-fibre diet to discourage the development of bezoars.
- Nutritional supplements, multivitamin/minerals and in some cases enteral or parenteral feedings may be necessary to meet nutrition requirements.
- People with gastropathy and diabetes should be encouraged to self monitor blood glucose frequently to aid in adapting diabetes medications to abnormal glucose absorption and to improve overall glycemic control.

Considerations for insulin and/or insulin secretagogue users

Although registered dietitians cannot order diabetes medications for people with diabetes, they remain integral in the decision of which agent/regimen may be best suited for the eating habits and lifestyle of people with diabetes. It is essential that registered dietitians work closely with all other team members to ensure that the lifestyle of the individual with diabetes is not unduly compromised because of the choice of medicine or regime. Treatment of diabetes with medicine brings to light various considerations that do not exist when just treating with diet and physical activity alone. Some of these considerations are discussed below.

Hypoglycemia

The greater the effort to attain near-normoglycemia with insulin and/or insulin secretagogues, the greater the risk of hypoglycemia (4,118). Persons taking insulin and/or insulin secretagogues should always carry a source of fast-acting carbohydrate such as glucose tablets or fruit juice. These individuals should be taught to recognize the early symptoms of hypoglycemia and to treat this immediately with at least 10–15 g of carbohydrate. For some people, the amount may need to be increased and/or repeated. However, it is as important to avoid overtreating low blood glucose as it is to avoid undertreating (119). Continued treatment with carbohydrate until the symptoms of hypoglycemia disappear often results in extreme hyperglycemia prior to the next meal. Ideally, a capillary blood glucose test should be done before consuming carbohydrate to confirm a low blood glucose level exists and 10–20 minutes after eating to confirm treatment was appropriate. Depending on the individual, the reason for the low blood glucose, the diabetes medications used and the interval to the next meal, it may be necessary to follow the treatment with a snack to prevent the hypoglycemia from recurring.

Hypoglycemia may occur immediately after or during meals in individuals using regular insulin or fast-acting insulin analogues who have started the meal with their blood glucose in the 4–5 mmol/L range. In this instance, glucose administered against the mucosal lining of the mouth may be the most effective method of treatment. To help avoid such an incident, fast-acting analogue insulin users should be reminded to eat immediately or no later than 15 minutes after injection of insulin (120). People with frequent hypoglycemic episodes of this nature, which are not corrected with insulin dose adjustment, may consider taking insulin after the meal. Of interest, those on a fast-acting analogue may experience less hypoglycemia compared to those on regular insulin (121).

Metformin and alpha-glucosidase inhibitors do not usually cause hypoglycemia when used on their own. However, used in combination with insulin and/or an insulin secretagogues, the risk of hypoglycemia exists. Low blood glucose in insulin and/or insulin secretagogue users who also take an alpha-glucosidase inhibitor should only be treated with monosaccharides (such as glucose), since alpha-glucosidase inhibitors slow the absorption of disaccharides (i.e. sucrose) (122,123).

Weight

Weight often increases in people newly started on insulin and those with previous poor control who are attempting to achieve better control. This is usually a result of less caloric loss through glycosuria, a reduced resting metabolic rate resulting from better blood sugar control and, in some cases, rehydration. Consequently, persons with diabetes newly starting on insulin or more intensive insulin therapies may wish to consider, with their diabetes health care team, either increasing activity or decreasing food intake at initiation of therapy (124,125). Otherwise, weight loss and/or physical activity in those established on insulin

and/or insulin secretagogues may necessitate changes to these medications and possibly food intake, as previously discussed in the “Weight management and obesity” and “Exercise” sections of this document.

Carbohydrate counting

Carbohydrate counting can aid the person with diabetes in achieving better blood glucose control while providing considerable variety in the diet. Carbohydrate counting can be used in meal-planning strategies that allow for both consistent and inconsistent carbohydrate intake (i.e. with insulin to carbohydrate ratios) (126). In the Diabetes Control and Complications Trial, participants with a consistent carbohydrate intake generally found it easier to attain target blood glucose than those who ate carbohydrate inconsistently (119,125). However, since the focus is on carbohydrate, care must be taken to help the persons with diabetes achieve a nutritionally adequate diet.

New and future diabetes medications

Numerous new medicines for the treatment of diabetes have been or soon will be introduced into Canada. In the future, more insulin analogues, both fast- and slow-acting, will likely be available. As well, new insulin secretagogues are expected to be available in the near future. Registered dietitians and other diabetes health care team members need to educate themselves continually regarding the actions of these new medicines and possible effects on lifestyle that these medicines may have. Registered dietitians unfamiliar with diabetes medications and management strategies are encouraged to contact diabetes educators who have expertise in this area.

Recommendations

- The registered dietitian should work with the health care team to ensure that the appropriate medication/regime is prescribed to accommodate the lifestyle of the individual with diabetes.
- All insulin and insulin secretagogue users, their families and support persons should be instructed on how to prevent, recognize and treat low blood glucose.
- Individuals with diabetes should be informed of the likelihood of weight gain with initiation or intensification of insulin therapy. Reduced energy intake and/or increased physical activity may be considered at time of initiation of the new insulin therapy.
- Care should be taken to ensure those instructed to use carbohydrate counting for blood glucose control are also instructed on the basics of healthy eating and weight management.
- All diabetes health care team members should regularly seek to keep informed of diabetes management changes and advancements.

PREVENTION OF TYPE 2 DIABETES

People with established impaired glucose tolerance (IGT) or impaired fasting glucose (IFG) are at increased risk of developing type 2 diabetes (127–129) and heart

disease (130). Dietary modifications and physical activity have been reported as ways to reduce the development of type 2 diabetes (131). For this reason, the same nutrition guidelines that apply to people with type 2 diabetes are appropriate for individuals with IGT or IFG.

Recommendations

- Individuals with IGT or IFG should be provided with the same nutrition and physical activity guidelines that apply to people with type 2 diabetes.

SUMMARY

Nutrition management is a key component for the long-term health and quality of life for people with diabetes. The general principles for nutrition recommendations are the same for people with diabetes as those without the condition. However, it is important that the health care team work with people with diabetes in setting realistic goals that meet the individual's micro- and macronutrient, physical activity, lifestyle and medical needs. The registered dietitian is a key member in assisting the individual in reaching these goals.

Attaining and maintaining blood glucose and lipid levels as near-normal as possible and preventing and/or treating diabetes-related complications and any concomitant conditions is vital to maintaining the physiological health of people with diabetes. Registered dietitians are referred to the 1998 Clinical Practice Guidelines for the Management of Diabetes in Canada for guidance.

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