Summary of Key Recommendations

Nutrition Recommendations to Manage Prediabetes

Lifestyle Interventions and Diabetes Prevention

- Support lifestyle modifications that include positive changes to eating and physical activity habits that:
  - improve insulin sensitivity, lower blood glucose, and manage blood pressure.
  - delay the progression towards type 2 diabetes through achieving and maintaining moderate weight loss (5–10% of initial body weight). Refer to Nutrition Guidelines: Adult Obesity Care for information about specific interventions for weight management.

Dietary Patterns

- Support a healthy dietary pattern that best aligns with the person's culture, values, preferences, and treatment goals; and consider financial resources and food skills.
- Encourage:
  - whole foods over refined/processed foods
  - whole grains, vegetables, fruits, nuts, seeds, legumes, healthy oils, and white meat/seafood
  - limiting the intake of red and processed meats and sugar-sweetened beverages

Meal Timing

- Distribute meals over the day and consume more calories earlier in the day to support optimal glycemic management and cardiovascular risk reduction.

Carbohydrates

- To lower blood glucose and cardiovascular risk:
  - Choose high-fibre carbohydrate foods, such as whole grains, beans, lentils, fruits, and starchy vegetables (e.g. corn, potatoes, winter squash).
  - Limit the consumption of foods and beverages containing high levels of added sugars.
  - Replace high-glycemic index (GI) carbohydrate foods (GI score of ≥70; e.g. white bread) with low-GI carbohydrate foods (GI score ≤55; e.g. heavy mixed grain bread).

Fats

- Choose moderate intakes of healthy fat (monounsaturated and polyunsaturated fat), and lower intakes of saturated fat and trans-fat to help reduce the risk of cardiovascular disease (CVD) and progression towards type 2 diabetes.
    - When possible, avoid replacing dietary fat with refined or highly processed carbohydrates (e.g. sugar or white flour).

Vitamins

Monitor for vitamin B_{12} deficiency in individuals on long-term (>4 years) metformin treatment.

Introduction

The purpose of the Adult Prediabetes Nutrition Guideline is to provide health professionals with an overview of the evidence-based nutrition recommendations for adults with prediabetes and provide answers to commonly asked questions (See Key Questions List).

The Nutrition Guideline was developed by the Adult Diabetes Nutrition Practice Working Group and is based on scientific evidence or best practice as recommended by national and international diabetes organizations (e.g. Diabetes Canada and American Diabetes Association). It was reviewed by health professionals across the province and members of the Diabetes, Obesity and Nutrition Strategic Clinical Network. If you have questions about this Nutrition Guideline, please contact Nutrition_Resources@ahs.ca.

This information is intended as a general resource only and is not meant to replace the medical counsel of a physician or individual consultation with a registered dietitian (RD). It is the responsibility of health professionals to evaluate the situation of each patient in their care, and apply the Nutrition Guideline appropriately. Individuals who are at high risk of malnutrition or who have a medical condition that is impacted by nutrition should be referred to an RD.

Note: For purposes of this Nutrition Guideline, the single term patient will be used to refer to clients, patients, and residents.

Referral to a Registered Dietitian

For more information on referral to an RD and RD services available in Alberta Health Services (AHS):

- See Nutrition Guideline: Referral to a Registered Dietitian
- Visit Referring Patients for Nutrition Services

Key Questions List

Key nutrition questions related to Adult Prediabetes care addressed in this Nutrition Guideline are listed below.

Definitions

- What is prediabetes?
- What are impaired fasting glucose (IFG), impaired glucose tolerance (IGT), and insulin resistance?

Eating to Manage Prediabetes and Prevent Type 2 Diabetes

- Can a person with prediabetes prevent or delay developing type 2 diabetes through lifestyle interventions?
- What dietary approaches reduce the risk of developing type 2 diabetes?
- What does healthy eating for prediabetes look like?

Carbohydrates and Fibre

- What are carbohydrates and how do they affect prediabetes?
- How much carbohydrate is recommended for a person with prediabetes?
- What is the glycemic index and can it help someone with prediabetes?
- How much fibre is recommended for people with prediabetes?
- What types of high fibre foods are recommended for lowering the risk of type 2 diabetes?

Sugars and Sugar Substitutes

- Can individuals with prediabetes consume sugar and sugar-sweetened foods and beverages?
- What sugar substitutes are safe to use for someone with prediabetes?

Fats

- What is the recommended amount of dietary fat for someone with prediabetes?

Sodium

- What are the recommendations for daily sodium (salt) for someone with prediabetes?

Eating Environment

- What behaviours and food skills can support improving dietary choices?
- What are the recommendations for making healthier choices when eating out?

Vitamin, Minerals, and Natural Health Products

- Are there vitamins, minerals or other natural health products recommended to reduce type 2 diabetes risk?

Alcohol and Caffeine

- Does alcohol affect the risk of developing type 2 diabetes?
- Does coffee or caffeine affect the risk of developing type 2 diabetes?

Weight

- How does body weight affect prediabetes and an individual's health risk?
- What is an individual's best body weight when they have prediabetes?

Physical Activity

- Why is physical activity an important factor in the prevention of type 2 diabetes?
- What type of physical activity is recommended for individuals with prediabetes?

Medications and Glucose Monitoring

- What are the nutrition implications of the medications used to prevent progression to type 2 diabetes?
- Is glucose monitoring required for individuals with prediabetes?

Additional Considerations

- How can I support a person with prediabetes facing financial strain and household food insecurity?

Resources

- What resources are available for patients?
- What resources are available for health professionals?

Answers to Key Questions

Definitions

Return to Key Questions List

What is prediabetes?

Prediabetes is a term that describes blood glucose levels that are higher than normal but are not high enough to diagnose diabetes. Prediabetes includes impaired fasting glucose (IFG), impaired glucose tolerance (IGT), and/or an A1c of 6.0–6.4% (Table 1).[1]

Having prediabetes increases an individual's risk of developing other chronic diseases such as type 2 diabetes and cardiovascular disease (CVD).[1] Not all individuals with prediabetes will progress to type 2 diabetes, but those who have both IFG and an A1c in the prediabetes range are at very high risk for developing type 2 diabetes in a five-year period.[1,2] Lifestyle interventions can be very effective in delaying or preventing the onset of type 2 diabetes in people with prediabetes.[3] The earlier the lifestyle interventions are initiated, the greater the reduction in the risk of developing type 2 diabetes.[4]

Table 1. Diagnosis Criteria for Prediabetes and Diabetes[1]

Laboratory Test	Reference Standards	
	Prediabetes*	**Diabetes***
Hemoglobin A1c	6.0–6.4% [Grade B]	≥6.5% [Grade B]
FPG	6.1–6.9 mmol/L (IFG) [Grade A]	≥7.0 mmol/L [Grade B]
Random glucose	n/a	≥11.1 mmol/L [Grade D]
2 hour postprandial OGTT**	7.8–11.0 mmol/L (IGT) [Grade A]	≥11.1 mmol/L [Grade B]

FPG = fasting plasma glucose; IFG = impaired fasting glucose; IGT = impaired glucose tolerance

*Diagnosis of diabetes or prediabetes requires a second positive lab test on a subsequent day **when no symptoms of hyperglycemia are present**. [Grade D][1] This is not required if the person is symptomatic of hyperglycemia or when type 1 diabetes is suspected.[5]

**OGTT: 2-hour postprandial blood glucose with a 75 g oral glucose tolerance test (OGTT). This test is stopped if the fasting blood glucose is >7.8 mmol/L, including if the reading was from a glucometer.[1]

For information about diagnosing prediabetes and screening for type 2 diabetes refer to Diabetes Canada's Clinical Practice Guidelines.

What are impaired fasting glucose (IFG), impaired glucose tolerance (IGT), and insulin resistance?

Impaired fasting glucose (IFG) is diagnosed using fasting plasma glucose (FPG), and **impaired glucose tolerance (IGT)** is defined by a two-hour postprandial OGTT result, as indicated in Table 1 (above). These conditions are characterized by insulin resistance and/or reduced insulin secretion.

Insulin resistance occurs when the body does not use insulin properly or as efficiently. This may increase the requirements from the pancreas to produce more insulin to help transport the glucose into the muscle, liver, and fat cells. When the pancreas struggles to meet insulin production demands due to insulin resistance, blood glucose levels increase causing hyperglycemia and setting the stage for prediabetes and type 2 diabetes.[6]

Individuals who have both IFG and IGT are at higher risk for type 2 diabetes and CVD compared to people with either IFG or IGT alone.[1] Regardless, all people with prediabetes (i.e. IFG and/or IGT) can benefit from both diabetes and vascular risk reduction interventions.[7]

Eating to Manage Prediabetes and Prevent Type 2 Diabetes

Return to Key Questions List

Can a person with prediabetes prevent or delay developing type 2 diabetes through lifestyle interventions?

Lifestyle modification programs for people with prediabetes can reduce the risk of developing type 2 diabetes. Lifestyle intervention programs include:[3,8,9]

- eating a diet that is high in fibre, low in total fat, and saturated fat
- engaging in moderate-intensity physical activity (e.g. minimum of 150 minutes per week over five days)
- aiming to achieve and maintain a weight loss of 5–10% initial body weight

Individual lifestyle modifications (e.g. improving eating habits or increasing physical activity) independently contribute to a reduced risk for type 2 diabetes; however, achieving more of these individual lifestyle modifications can lead to greater protection against diabetes.[10]

Pharmacologic therapy (e.g. metformin or a GLP-1 inhibitor for weight management) may be considered in some individuals in combination with lifestyle intervention if lifestyle goals and/or metabolic targets are not achieved.[3] Physician consultation is required.

For more information on treatment options for people living with obesity refer to Nutrition Guideline: Adult Obesity Care.

What dietary approaches reduce the risk of developing type 2 diabetes?

Nutrition therapy is a fundamental part of the treatment plan for the management of prediabetes and the prevention of type 2 diabetes.[11,12] Adhering to a healthy dietary pattern has been associated with an approximate 20% risk reduction of developing type 2 diabetes.[13] There is no one special diet for people with prediabetes, but there are several dietary patterns that are associated with a reduced risk of progressing to type 2 diabetes.[13] Healthcare providers are encouraged to support patients to choose a healthy dietary pattern that best aligns with the patient's values, preferences, and treatment goals. This includes considerations for the patient's culture, lifestyle, economic status, activity level, and other health conditions.

Canada's food guide provides healthy eating guidelines.[14] Other examples of healthy dietary patterns include the Mediterranean diet,[15] DASH diet, and other healthy dietary approaches that emphasize plant-based whole foods over refined/processed foods.[13] The general principles of these dietary approaches are to include whole grains, vegetables, fruits, nuts, seeds, legumes, healthy oils, poultry, and seafood, and to reduce the intake of red and processed meats and sugar-sweetened beverages.

For more information about different dietary patterns refer to Nutrition Guidelines: Heart Health, Hypertension.

What does healthy eating for prediabetes look like?

Eating three regular meals per day, and snacks if needed, can assist individuals with prediabetes to meet their nutrient requirements. This approach, especially when it promotes eating more calories earlier in the day, can also support good glycemic management and cardiovascular risk reduction.[16] It is best to individualize the frequency and consistency of meals and snacks based on an individual's lifestyle, mealtime preferences, and health goals.

A nutritionally balanced meal includes a variety of vegetables, fruits, whole grains, and protein-rich foods.[14] Diabetes Canada's Balanced Food Plate is a plate model that can be used for people with prediabetes to provide an example of a balanced meal.[17] This resource is an adapted version of Canada's food guide and provides modified recommendations about fruit and starchy vegetables (Table 2).

Table 2. Comparison of Canada's Food Guide and Diabetes Canada's Balanced Food Plate

	Canada's Food Guide	Diabetes Canada's Balanced Food Plate
Recommendations	• ½ plate vegetables and fruit	• ½ plate non-starchy vegetables and small portion of fruit. • Fruit may be included with a meal or as a snack
	• ¼ plate whole grains	• ¼ plate whole grains and starchy vegetables
	• ¼ plate protein foods • Choose protein foods that come from plants more often	• Same as Canada's food guide

Breakfast does not include vegetables for some people. When addressing breakfast recommendations with patients, encourage protein foods along with carbohydrate foods (e.g. fruit, whole grains). When appropriate, discuss choosing high fibre and/or lower glycemic index carbohydrate foods at breakfast to assist with managing the blood glucose response to the meal. See the Carbohydrate and Fibre section of this Nutrition Guideline for more information.

Portion Sizes

Larger portions can lead to increased calorie and carbohydrate intake, resulting in increased blood glucose after meals and increasing cardiovascular risk. By distributing foods as illustrated by Diabetes Canada's Balance Food Plate, individuals will be more likely to have appropriate portions.

Individuals with prediabetes may benefit from additional education about portion sizes that can lower their blood glucose and achieve their best weight.

Using the patient's hands is a strategy for guiding portion sizes:[18]

- Using a fist to guide portions of grain/starches or fruit serving size.
- Using two handfuls to guide the serving size of vegetables at a meal.
- Using the palm and thickness of the little finger to guide serving size for meat, fish, or poultry.
- Using the tip of the thumb to guide the serving of added fat.

Snacks

People with prediabetes may benefit from including healthy snacks into their day to help meet their nutrient needs, manage their hunger, and prevent overconsumption at meal times. Snacks that include one or two different types of foods that are high in fibre, include some protein, and contain limited or no added sugars or fats are recommended (see Table 3).

Table 3. Snack Examples for People with Prediabetes

Food Grouping	Examples
Vegetables and Fruit	• Vegetables, raw • Fruit, fresh or canned unsweetened
Grain Products	• Crackers, whole grain (e.g. Ryvita® or Wasa®) • Bread, whole grain • Popcorn, plain • Cookies, low-fat (e.g. digestive or arrowroot) • Cereal, high-fibre (4 grams or more fibre per serving)
Protein Foods	• Milk, skim, 1%, or 2% M.F. • Yogurt, plain or sugar-free • Cottage cheese, 1% or 2% M.F. • Egg, hardboiled • Nut butter • Nuts or seeds, unsalted • Tuna, canned • Hummus

% M.F. = % Milk Fat

Carbohydrate and Fibre

Return to Key Questions List

What are carbohydrates and how do they affect prediabetes?

Carbohydrates include sugar, starch, and fibre. Sugar and starch are the carbohydrates that increase blood glucose and provide the body with a readily available energy source. Dietary fibre is also a carbohydrate but is not metabolized into blood glucose.[19]

People with prediabetes can reduce their cardiovascular risk and progression toward type 2 diabetes by following a dietary pattern that encourages higher fibre carbohydrate foods such as whole grains, legumes, fruits, and starchy vegetables (e.g. corn, potatoes, and squash).[11] Foods and beverages containing high amounts of added sugars are considered lower-quality carbohydrate sources. Limiting the consumption of these foods can help reduce cardiometabolic risk factors (e.g. triglycerides and blood pressure).[11] Reducing or avoiding the consumption of sugar-sweetened beverages is particularly important because a high intake (>10% of total calorie intake) is strongly associated with the risk of hypertension and heart disease in people with and without diabetes.[11]

How much carbohydrate is recommended for a person with prediabetes?

There is no strong evidence for a specific amount of dietary carbohydrate that will prevent type 2 diabetes.[12] The type of carbohydrate appears to be a more important dietary factor than the quantity of carbohydrate.[12,20]

The amount of carbohydrate required by an individual is specific to their needs (age, body size, activity level). For example, a person who lives a very active life may require a higher amount of carbohydrate, whereas a smaller and less active individual may need less carbohydrate.

Restricted carbohydrate diets, including ketogenic diets, have gained increasing interest over the past decade. Table 4 provides definitions and descriptions most commonly used in the literature to define these diets.

Table 4. Restricted Carbohydrate Diet Descriptions[19,21,22]

Diet	Carbohydrate Amount*
Moderate carbohydrate	≥130 g carbohydrate daily and between 26–45% total energy from carbohydrate
Low carbohydrate	<130 g carbohydrate daily or <26% total energy from carbohydrate
Ketogenic (Very-Low Carbohydrate High Fat‡)	20–50 g carbohydrate daily or <10% total energy from carbohydrate

*Note: Carbohydrate refers to available or net carbohydrate, which is the total carbohydrate minus dietary fibre.
‡High fat typically refers to an intake of 65 to 80% of total energy from dietary fat.

Well-planned restricted carbohydrate diets are one of several dietary approaches that can be an effective strategy for glycemic management and reducing cardiovascular risk factors.[12,23] Results from restricted carbohydrate diet studies including people with prediabetes are mixed and depend on the study duration and type of dietary intervention (e.g. types of foods used to replace carbohydrate-rich foods).[24]

Individuals who choose to adopt a restricted carbohydrate diet are still recommended to consume a healthy dietary pattern including a variety of foods.[23] Carbohydrate-restricted diets may be difficult to follow for some people. As such, it is important for the patient to explore the benefits, challenges, and risks of the diet prior to initiation. A referral to an RD is recommended to ensure the diet provides adequate fibre, vitamins, and minerals, and does not contribute to the risk of cardiovascular disease (e.g. increase in low-density lipoprotein [LDL] cholesterol or triglycerides).[23,24] Individuals choosing a very-low-carbohydrate diet are safest under the supervision of an interdisciplinary medical team, including an RD.

Considerations

- Poorly planned restricted carbohydrate diets increase the risk of nutrient deficiencies.
- Very-low carbohydrate and high fat (ketogenic) diets are contraindicated for individuals with the following conditions:[25]
  - Pregnancy[26]
  - Inborn errors of fat metabolism
  - Renal stones
  - Severe dyslipidemia
  - Liver failure
  - Failure to thrive or poor oral intake
  - History of pancreatitis
  - Severe gastroesophageal reflux
  - Gastroparesis
  - Cardiomyopathy
  - Chronic metabolic acidosis

For more information on restricted carbohydrate diets, refer to Nutrition Guideline: Restricted Carbohydrate Diet.

What is the glycemic index and can it help someone with prediabetes?

The Glycemic index (GI) is a scale from 1 to 100 that ranks carbohydrate-containing foods based on their ability to raise post-prandial blood glucose levels.[27] High GI foods (≥70 out of 100) have the potential to cause a rapid rise in blood glucose after consumption, while low GI foods (≤55 out of 100) produce a lower blood glucose response.[27]

Many factors can affect the GI of a food, including the amount of fibre, protein and/or fat, the type of carbohydrate, the acid content, food processing, and cooking methods. For more information regarding GI please see www.glycemicindex.com.

Meta-analysis of large cohort studies suggests that a higher GI diet is associated with an increased risk for type 2 diabetes.[28,29] Replacing high-GI foods with low-GI foods may improve glycemic management in people with insulin resistance.[11,30]

Education on GI can be provided based on the patient's interest and ability.[11] GI is an advanced concept, as many factors affect the GI of a food and individuals will require additional education to use it successfully.[27] The GI is a tool to help guide food choices but serving sizes are also an important consideration when choosing low GI foods. In addition, nutrition guidelines for overall health remain an essential factor.

Tips to use the GI as a tool to improve blood glucose management:[30]

- Enjoy vegetables, fruits, and milk products with meals. These generally have a low GI.
- Plan meals using medium and low GI grains or starches. See examples in Table 5.
- Limit intake of foods with a high GI and aim to find acceptable lower GI replacements (see Table 5).

Table 5. Glycemic Index Food Example List[30]

Low GI (≤55) Foods	Medium GI (56–69) Foods	High GI (≥70) Foods
• Breads: 100% stone-ground whole wheat, heavy mixed grain, sourdough • Cereals: All-Bran®, psyllium, oat bran • Grains: barley, bulgur • Pasta: al dente cooked pasta/noodles • Rice: parboiled, converted • Starchy vegetables: sweet potato, yam, legumes (beans, lentils, and peas)	• Breads: whole wheat, rye, pita bread • Cereals: puffed wheat, oatmeal • Crackers: Stoned Wheat Thins™, rye crisps • Pasta: couscous • Rice: basmati, brown, wild rice • Starchy vegetables: new/white potatoes, sweet corn, popcorn	• Breads: white, bagels • Cereals: All-Bran® Flakes, Corn Flakes®, Rice Krispies® • Crackers: soda crackers • Rice: short-grain, Jasmine • Rice cakes • Pretzels • Starchy vegetables: Russet potatoes, French fries

How much fibre is recommended for people with prediabetes?

People at risk for diabetes, including those with prediabetes, are encouraged to consume at least the amount of dietary fibre recommended for the general public (Table 6).[12]

Table 6. Recommendations for Daily Fibre Intake to Prevent Disease in Adults[19]

Males		Females	
Age (years)	**Fibre per day (g)**	**Age (years)**	**Fibre per day (g)**
19–50	38	**19–50**	25
Over 50	30	**Over 50**	21

What types of high fibre foods are recommended for lowering the risk of Type 2 diabetes?

Dietary fibre is categorized into two types: insoluble and soluble fibres. **Insoluble fibre** is not water-soluble and is known as a bulking fibre that promotes regular bowel movements.[31] **Soluble fibre** dissolves in water.[31] This fibre readily ferments in the large intestine by microflora. Most foods will have a mixture of both fibre subtypes.[31]

High sources of insoluble and soluble fibre include:

- **Insoluble fibre:** cereal grains like wheat bran, whole grains, vegetables, fruits, and legumes (beans, lentils, and peas)
- **Soluble fibre:** oat bran, oatmeal, psyllium, fruit (e.g. avocados, pears, apples, nectarines, plums, oranges), legumes, and barley

Viscous soluble fibre is a subtype of soluble fibre that may be specifically beneficial for individuals with prediabetes. High fibre diets that contain at least a third of the fibre as viscous soluble fibre (>10 grams per day) have been shown to reduce fasting blood glucose and improve blood lipids.[11] Viscous soluble fibre is found in plant sources such as oats, barley, pulses, eggplant, and temperate fruits (e.g. apples and pears).

For more general information about fibre, refer to Nutrition Guideline: Fibre.

For more information about the effect of fibre on obesity or cardiovascular disease management, refer to the respective Nutrition Guidelines: Adult Obesity Care and Heart Health

Sugar and Sugar Substitutes

Return to Key Questions List

Can individuals with prediabetes consume sugar and sugar-sweetened foods and beverages?

Dietary sugars include total sugars, free sugars, and added sugars (see Figure 1).[32,33] It is recommended for people with prediabetes to follow a diet that contains I<5% or up to 10% of total energy from free sugar.[11,34] Table 7 summarizes the recommended **maximum** daily amount of free sugar and teaspoons of sugar equivalents based on daily caloric intake.

Figure 1: Types of Dietary Sugars[32]

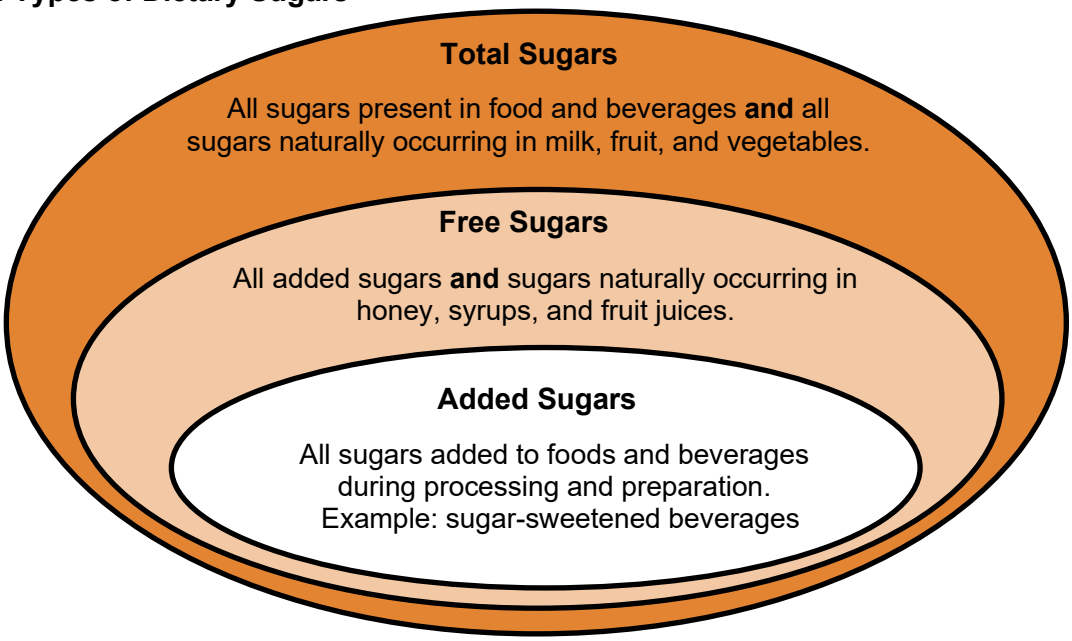

Table 7. Recommended Maximum Daily Free Sugar Allowance Based on Daily Calorie Intake

Daily Calorie Intake	Maximum Total Daily Free Sugar*	Teaspoons of Sugar (4g/tsp)**
1200–1500 kcal	30–38 g	7.5–9 tsp
1600–1800 kcal	40–45 g	10–11 tsp
1900–2100 kcal	48–53 g	12–13 tsp

*Equation: 10% total daily energy ÷ 4 kcal/g of carbohydrate

**Note: 1 can (355 mL) of sugar-sweetened carbonated beverage (e.g. cola) provides approximately 40 g added sugars or the equivalent of 10 tsp sugar.

Excess **added sugar** intake, especially in the form of sugar-sweetened beverages, is linked to negative health outcomes including obesity, prediabetes, type 2 diabetes, inflammation and CVD.[11,32] **Free sugars** (including added sugars) and food products that contain them can displace more nutritious foods in the diet.[32] **Natural sugars** are in a variety of nutritious foods, such as fruit and milk products, that are part of a healthy diet.[32] Table 8 provides examples of beverages that may contain naturally occurring sugar versus the sugar that has been added by the food processor.

Table 8. Comparing Naturally Occurring Sugars and Added Sugar in Commonly Consumed Items[35]

Serving Size	Foods Items				Sugar Added Difference
	Naturally Occurring Sugar		Added Sugar		
1 can (355 mL)	Club Soda	0 g	Regular Cola	39 g	39 g (10 tsp.)
2 cups (16 oz)	Café latte	18 g	Vanilla café latte	35 g	17 g (4 tsp.)
1 cup (250 mL)	Plain milk	13 g	Chocolate milk	33 g	20 g (5 tsp.)

People with prediabetes can reduce added and free sugar by limiting or avoiding:

- Added sugars or honey in coffee and tea
- Sugar-sweetened beverages: pop, energy and sports drinks, specialty coffees.
- High sugar desserts: baked goods like muffins and donuts, granola bars, cakes, cookies, candy, and chocolate
- High sugar condiments: ketchup, BBQ sauce, jam, syrup, sweet sauces, and honey

Nutritious options that can help to reduce the intake of added sugars include:

- Fresh fruits or canned or frozen, unsweetened, or no sugar added fruits
- Homemade milk pudding, made with low-fat milk or plant-based beverages, and low in sugar
- Lower-fat yogurt that is plain, sugar-reduced, or sweetened with a sugar substitute

What sugar substitutes are safe to use for people with prediabetes?

Sugar substitutes include artificial sweeteners, high-intensity sweeteners, and sugar alcohols.[36] When consumed below the acceptable daily intake (ADI), sugar substitutes are safe for people with prediabetes (Table 9).[11,37]

Table 9. Sugar Substitutes Approved for Use in Canada[38,39]

Sweetener	Common name and brand name*	ADI (mg/kg/day)	Quantity required to reach daily limit**
Acesulfame-potassium	Sunett®	0–15	25 cans diet soda
Aspartame	Nutra-Sweet®, Equal®, Sweet 'N Low®, private labels	0–40	14 cans diet soda
Cyclamates* **	Sucaryl®, SugarTwin® and Sweet 'N Low®	0–11	3 packets Sugar Twin
Neotame	Not common	0–2	n/a
Saccharin	Hermesetas® (only purchased at pharmacies)	0–5	29 packets
Steviol glycosides	Truvia®, SugarTwin® Stevia, Krisda®, Pure Via™	0–4	10 packets Truvia
Sucralose	Splenda®, Sugar Twin Sucralose®	0–8.8	51 packets
Thaumatin	Not common	0–0.9	Information not available
Monk Fruit extract (Luo Han Guo Extract)	Lakanto®, Splenda®, Whole Earth® (products often include erythritol or stevia)	Not established†	No upper limit set

*Brand names are provided as examples only and are not an endorsement.
**Quantity based on 70 kg (154 lb) person.
***Caution patients about the use of cyclamates. Consumers can easily exceed the ADI compared to other sugar substitutes.
† Monk Fruit is generally recognized as safe (GRAS) by the Food & Drug Administration (FDA) but does not have an established ADI.[40] It is approved as a tabletop sweetener by Health Canada.[41]

Sugar substitutes:

- can be used in moderation and should not replace nutrient-dense food choices[42]
- can reduce calorie intake when substituted for added sugars and/or other carbohydrates[12]
- have little effect on blood glucose and can assist to lower the glycemic response to a food/meal when substituted for added sugars and/or other carbohydrates[12,42]

It is important to note that foods may state "sugar-free" or "no sugar added" on the label but can be high in fat, calories, low in fibre, and may still contain carbohydrate. Some individuals with prediabetes may eat large quantities of these sweetened foods believing them to be healthier choices. To ensure that products sweetened with sugar substitutes are not replacing more nourishing foods, moderation is encouraged.

Sugar alcohols (polyols) provide an average of 2 kcal/g but have little to no affect on blood glucose.[11,36,39] Sugar alcohols include sorbitol, mannitol, xylitol, erythritol, D-tagatose, Isomalt, lactitol, maltitol. It is recommended to limit intake of sugar alcohols to ≤10 g/day to reduce risk of gastrointestinal side effects.[11]

For individuals who are pregnant or are planning pregnancy, refer to the Nutrition Guideline: Pregnancy for additional statements about the use of cyclamates and stevia leaves.

Refer to Nutrition Guideline: Sugar Substitutes for more information on this topic.

Fats

Return to Key Questions List

What is the recommended amount of dietary fat for someone with prediabetes?

Dietary fat in food is categorized into four types: monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), saturated fat and trans fat (See Table 10). The ideal amount of fat for people with prediabetes has not been determined.[12] The guidelines to prevent chronic disease for the general population are applied to people with prediabetes. These guidelines recommend that 20–35% of total daily energy come from fat with <9% of total daily energy coming from saturated fat and minimal intake of trans fats.[11]

Table 10. Types of Dietary Fat, Recommended Intake for Cardiovascular Health and Food Sources

Type of Dietary Fat & Recommendations	High Dietary Sources
Monounsaturated fatty acids (MUFA)	
Cardiovascular protective. Use as a replacement for high saturated fat sources.	• Avocado, olives • Vegetable oils made from olives, canola, safflower, sunflower and sesame seeds • Nuts or nut butters made from peanuts, sunflower and sesame seeds (nut butters without hydrogenated oils/fats and added salt/sodium are recommended)
Polyunsaturated fatty acids (PUFA)	
Cardiovascular protective. Encourage dietary sources of omega-3.	• Sources of omega-3 PUFAs: fatty fish, seaweed, kelp, algae, walnuts, flaxseed, chia seed, hemp seed, canola oil, walnut oil, flaxseed oil, foods fortified with omega-3 (e.g. some eggs, juice, milk, margarines, and yogurts. • Sources of omega-6 PUFAs: Nuts, seeds, corn oil
Saturated Fatty Acids (SFA)	
Limit to <9% of calories per day.	• Animal origin*:* fat in beef, lamb, pork, chicken, poultry skin, processed meats, dairy (cheese, cream, milk, yogurt), and lard. • Plant origin: cocoa butter, coconut oil, and palm or palm kernel oil.
Trans Fatty Acids	
Minimal intake and avoid when possible.	• As of September 2018, the Government of Canada has legislated the prohibition of using partially hydrogenated oils in foods, thereby significantly reducing the amount of trans fats in the Canadian food supply.[43] • Refer to Nutrition Guideline: Heart Health for more information about trans fats.

The type of fat may be more important than fat quantity.[11,12] For people with prediabetes, reducing vascular risk and progression toward type 2 diabetes is an important treatment goal. This can be achieved by focusing on consuming a diet with moderate amounts of healthy fat (MUFA and PUFA), and low in saturated fat and trans-fat.[3,32]

Care should be taken to avoid replacing fat with refined or highly processed carbohydrates such as sugar or white flour.[44,45] If dietary adjustments are needed, replacing saturated and trans fats with mono- and polyunsaturated fats and whole grains or low GI carbohydrate foods (e.g. barely, quinoa, steel cut oats) is recommended.[11]

For more information about:
- different types of dietary fat and cardiovascular risk reduction refer to Nutrition Guideline: Heart Health.
- reading food labels refer to Nutrition Guideline: Label Reading.

Sodium

Return to Key Questions List

What are the recommendations for daily sodium (salt) for someone with prediabetes?

Prediabetes increases the risk for vascular disease.[5] It is best practice to support individuals with prediabetes to limit their sodium intake to prevent and manage hypertension and to reduce the risk of cardiovascular disease and kidney disease.[46] Limiting sodium intake to 1500–2000 mg/day is recommended to prevent hypertension.[47] A sodium intake of between 1500–2300 mg/day is recommended for the management of hypertension.[48] This sodium recommendation also applies to individuals with prediabetes.[12]

Refer to Nutrition Guideline: Hypertension for more information about dietary sodium and tips to lower sodium intake.

Eating Environment

Return to Key Questions List

What behaviours and food skills can support improving dietary choices?

Many highly processed, but easy-to-prepare foods are high in free (added) sugars and salt, and can therefore undermine efforts to improve diet quality.[32] An individual's level of cooking and food preparation skills can influence their dietary choices. A low level of skill can be a barrier to implementing nutrition knowledge or recommendations. It is important to consider a patient's food skills and eating environment when discussing dietary change options.[11] Referring patients with low levels of food skills or limited cooking resources to a dietitian or other appropriate programs can help to implement and sustain desired dietary behaviours.

What are the recommendations for making healthier choices when eating out?

Restaurants, including fast food and cafes, often serve foods higher in fat, sodium, added sugar and refined carbohydrates (i.e. higher glycemic index and low in fibre). Portions are also generally much larger and there may be multiple courses served that typically are not eaten at home.[49] The overall increased intake and higher caloric density of the foods can lead to weight gain over time.[50] For individuals with prediabetes, limiting the frequency of eating out is ideal; however, the convenience of eating out or ordering in is part of the typical North American lifestyle. Supporting patients to make informed healthy decisions when choosing to eat out can assist with achieving their health goals.

Tips for managing portions, sodium, sugar and fat intake when eating out:

- Share meals with someone or ask for half of the meal to be packaged ahead of time.
- Avoid fried appetizers, side dishes, and entrees.
- Aim for ½ plate of vegetables and fruit.
- Ask for leftovers to be packed up.
- If really hungry before going out to eat, consume a small snack.
- Consider a tossed salad with lower fat dressing on the side as a starter course.
- Limit eating out to two times per week or less.
- Reduce intake of beverages with added sugars or alcohol.
- Check nutrition information online to look for lower calorie choices.

Vitamin, Minerals, and Natural Health Products

Return to Key Questions List

Are there vitamins, minerals or other natural health products (NHP) recommended to reduce type 2 diabetes risk?

There is no indication for routine supplementation of vitamins and minerals or NHPs for the prevention of type 2 diabetes. Supplementation to support dietary deficiencies is determined on an individual basis. Nutrition needs can be met by following a nutritious and balanced diet. To reduce the risk of overdosing on certain nutrients or interactions with medications, it is best practice to ask patients if they are taking vitamins, minerals, or NHPs.

Below is a summary of evidence and recommendations for some vitamins, minerals, and NHPs often inquired about.

Vitamin D

There is no indication for additional supplementation of vitamin D to improve glycemic management and prevention of type 2 diabetes.[51] Vitamin D is found naturally in foods like fish and egg yolks.[35,52] Foods such as margarine, milk, yogurt, and some soy, rice, and almond beverages have been fortified with Vitamin D and other nutrients.[35,52] In Alberta it is unlikely to obtain adequate vitamin D through sun exposure and food sources; therefore, supplementation is necessary for most people.

Refer to Nutrition Guideline: Calcium and Vitamin D for Prevention and Treatment of Osteoporosis

Magnesium

It is thought hypomagnesemia (low serum magnesium) is associated with insulin resistance.[53,54] Prospective cohort studies suggest higher dietary magnesium intake is associated with a reduced risk of developing diabetes but more research is needed to determine the efficacy of magnesium supplementation for this purpose. Eating a healthy diet, including foods rich in magnesium such as whole grains, legumes (beans, lentils, and peas), nuts, vegetables, and fruits is recommended.

Fish oil and/or omega-3 fatty acids

Although supplementing with omega-3 fatty acids has shown to decrease triglycerides when taken in large doses (2–4 g/d), the Canadian Cardiovascular Society does not recommend the use of over-the-counter supplements to reduce CV risk.[55,56] Supplements should be taken on the advice of a physician or RD. Refer to Nutrition Guideline: Heart Health.

Chromium

Although there have been some reported beneficial effects from supplementation of chromium on glycemic management, a conclusive association between chromium and improved insulin sensitivity has not been demonstrated.[57]

Cinnamon

There is insufficient evidence to support the use of cinnamon to lower blood glucose levels.[57,58] There is no significant difference in A1c, postprandial glucose, or serum insulin levels when compared to controls.[59] However, the use of dietary cinnamon is safe.

Alternative natural therapies

There is currently insufficient evidence to recommend individual herbs and supplements for the prevention of diabetes; however, they appear to be generally safe. Several supplements may warrant further research to encourage use in the prediabetes population.[57]

Alcohol and Caffiene

Return to Key Questions List

Does alcohol affect the risk of type 2 diabetes?

The general recommendation for adults is to follow Canada's Low Risk Alcohol Drinking Guidelines to minimize an individual's overall health risk. For individuals with prediabetes, recommendations are the same as those for the general population.[11,60] Alcohol consumption greater than 3–4 standard drinks per day is likely associated with an increased risk of developing type 2 diabetes, compared with moderate alcohol consumption.[12,61] Moderate intakes of alcohol (1 to 2 standard drinks per day) may help prevent type 2 diabetes in those with prediabetes.[12] Those abstaining from alcohol should not be advised to start drinking to achieve these health benefits.[12]

Table 11. Canada's Low-Risk Drinking Guidelines

	Per Day	Per Week
Males	0–3 standard drinks	15 maximum
Females	0–2 standard drinks	10 maximum

Table 12. One Standard Drink Equivalents

Alcohol Type	Amount	Alcohol by Volume (ABV)
Distilled alcohol	43 mL (1.5 fl. oz)	40%
Wine	142 mL (5 fl. oz)	12%
Beer, cider, cooler	341 mL (12 fl. oz)	5%

Considerations

- Higher intake than recommended may increase blood pressure and triglycerides, as well as an increase in total caloric intake.
- **For people with hypertension**, it is recommended to limit their intake of alcohol to two drinks or less daily.[62] Refer to Nutrition Guideline: Hypertension and Heart Health for more information.

Does coffee or caffeine affect type 2 diabetes risk?

Observational studies have indicated a protective effect from habitual coffee consumption on the risk of developing type 2 diabetes.[63–65] However, these effects may be a result of constituents in coffee other than caffeine, as other studies have shown that decaffeinated coffee also contributes to the reduced risk.[66] More research is required before a definitive recommendation can be made.

Health Canada recommends that healthy adults limit their caffeine intake to no more than 400 mg/day of caffeine.[67] Caffeine consumption above this level may result in adverse health effects of coffee and caffeine intake such as sleep disruption, irritability, and nervousness. Caffeine content can vary greatly among teas, coffees and caffeinated beverages (e.g. pop, energy drinks). In general, 400 mg caffeine is approximately equivalent to three cups (1 cup = 8 oz or 237 mL) of coffee per day.

Consideration

Individuals who are planning to become pregnant, are pregnant, or lactating should limit caffeine to a maximum of 300 mg/day.[67] Refer to Nutrition Guideline: Pregnancy.

Weight

Return to Key Questions List

How does body weight affect prediabetes and an individual's health risk?

Excess body weight and the distribution of adiposity contributes to developing insulin resistance and increases the risk of developing type 2 diabetes.[68] Body Mass Index (BMI) and waist circumference (WC) are tools used to identify individuals at risk of developing these health conditions.

- A BMI greater than 30 (or having obesity) is a risk factor for developing chronic diseases such as type 2 diabetes.[69] BMI is not intended to be used to calculate an individual's "target" or "healthy" weight.
- WC is an indirect measure of both subcutaneous and visceral abdominal fat, which can contribute to the level of health risk. An elevated WC puts an individual at an increased risk of developing health concerns such as type 2 diabetes, CVD, and high blood pressure.[69]

The Edmonton Obesity Staging System (EOSS) is a tool that, in addition to BMI, considers the presence of other health risk factors and functional limitations to classify the severity of obesity, thereby providing a more accurate assessment of health risks associated with excess weight. The tool can be found at http://www.drsharma.ca/wp-content/uploads/edmonton-obesity-staging-system-staging-tool.pdf

For more information about BMI, WC, and EOSS refer to Nutrition Guideline: Body Measurements, Adult Obesity Care, and Seniors Health Overview.

Is weight loss recommended for patients with prediabetes?

For individuals with prediabetes and obesity, weight loss is often a central factor in reducing the risk of type 2 diabetes.[9] Lifestyle modifications, such as improving eating and physical activity habits, that result in a loss of 5 to 10% of initial body weight can significantly reduce the risk of progression to type 2 diabetes when compared to no interventions.[9,70] This modest weight loss may improve insulin sensitivity, lower blood glucose, and help to manage blood pressure.

Weight loss is a clinical outcome measure, but weight outcomes are not necessarily in the direct control of the patient. When counselling patients, it is recommended to focus on positive behaviour outcomes (e.g. reducing sugar-sweetened beverage consumption or increasing physical activity) that are within their control.

Weight loss is not sustainable if it is achieved by consuming the smallest amount of calories and doing the largest amount of exercise a person can tolerate.[71] The term “best weight” may be helpful when discussing a patient’s desire to lose weight.[71] Best weight is the weight a person achieves while living a life they truly enjoy.[71] Enjoyment includes consumption of the foods they love and doing the amount of exercise they enjoy.

Refer to Nutrition Guideline: Adult Obesity Care.

Physical Activity

Return to Key Questions List

Why is physical activity an important factor in the prevention of type 2 diabetes?

Physical activity can help:[72,73]

- increase cardiorespiratory fitness and muscle strength
- increase stamina
- improve glycemic management
- decrease insulin resistance
- improve lipid profile and blood pressure
- promote relaxation and reduce stress
- promote weight reduction, weight maintenance, and reduced body fat mass

Due to all the above-mentioned benefits, being physically active can help to reduce the risk of premature death, heart disease, stroke, hypertension, some cancers, type 2 diabetes, osteoporosis, and obesity.[72]

What type of physical activity is recommended for individuals with prediabetes?

For adults with prediabetes, a lifestyle program that includes a minimum of 150 minutes of moderate to vigorous intensity aerobic activity each week, spread over five days (in bouts of 10 minutes or more), is recommended.[72,73] This amount of physical activity is associated with a 26% risk reduction of developing type 2 diabetes and higher fitness levels are associated with greater risk reduction.[74] Table 13 describes types of physical activity, examples, and recommendations for individuals with prediabetes.

Table 13. Physical Activity Types, Examples, and Recommendations[72,73]

Description	Examples	Recommendations
Aerobic Activity		
Moderate Intensity: • Hard enough to break a sweat • Should be able to talk, but not sing	• Brisk walking • Water aerobics and continuous swimming • Lawn mowing • Riding a bike	• Work up to and maintain at least 150 minutes per week, preferably spread over 5 days per week • Activity lasts at least 10 minutes in duration. • No more than two consecutive days without exercise • Note: High-intensity interval training can increase aerobic fitness gains compared to moderate-intensity exercise
Vigorous Intensity: • Breathing hard and fast • Not able to say more than a few words without stopping for a breath	• Jogging or running • Swimming fast • Riding a bike fast or on hills • Aerobics • Hockey • Basketball	
Resistance Exercise		
Brief repetitive exercise that loads the muscle group and increases muscular strength and/or endurance	• Exercise with weight machines or free weights • Resistance bands • Using own body weight	• Two to three times per week • Periodic supervision recommended
Flexibility Exercise		
Includes balance training and stretching the muscles to allow joints to move through their full range of motion	• Yoga • Tai Chi • Stretching	• May be particularly important for older adults[73] • Lack of evidence for risk reduction in chronic disease

Non-exercise (light aerobic) physical activity such as slow walking or household tasks can provide additional health benefits, such as breaking up or reducing sedentary behaviours.[73]

Sedentary (sitting) behaviour is time spent with little physical movement and very low energy expended.[72] This may include sitting at a desk, using a computer, watching TV and/or driving in a vehicle. It is recommended to interrupt sedentary behaviour every 20 to 30 minutes with a brief (≤5 minutes) bouts of standing or light movement.[73]

Consideration

Recommend patients speak with their physician or physiotherapist prior to starting a physical activity program.

For more information about physical activity refer to Canadian Physical Activity Guidelines: www.csep.ca/guidelines

Medications and Blood Sugar Monitoring

Return to Key Questions List

What are the nutrition implications of the medications used to prevent progression to type 2 diabetes?

For some individuals with prediabetes pharmacological therapy may be required to assist in glycemic and weight management.[3] The decision to use pharmacologic therapy requires consultation between the individual and their physician to discuss the risks and benefits. Pharmacological therapy should be in conjunction with lifestyle interventions to support optimal and lasting results.[70]

Metformin

Metformin can improve glycemic management by lowering liver glucose production and increasing cellular glucose uptake (insulin sensitivity). Long-term use (>4 years) of more than 1000 mg of metformin daily can decrease the intestinal absorption of vitamin B_{12} and increase the risk of deficiency.[75] Serum measurements of vitamin B_{12} are available to identify deficiencies and periodic testing in those with anemia or peripheral neuropathy is suggested.[75,76] Prevention and treatment of vitamin B_{12} deficiency is possible with supplementation.

Intestinal symptoms such as nausea, diarrhea, and gas are common when initiating metformin.[9] To minimize gastrointestinal side effects it is recommended to take it with food[77] and to start a low dose and increase gradually.[78]

Obesity Medications (Pharmacotherapies)

Lipase inhibitors (orlistat [Xenical®]), naltrexone/bupropion combination (bupropion and naltrexone [Contrave®]) and glucagon-like peptide 1 (GLP-1) receptor agonists (liraglutide [Saxenda®] or semaglutide [Wegovy®]) are obesity medications with potential benefits of delaying the progression to type 2 diabetes in individuals with obesity and prediabetes.[79] Of note, trials demonstrating these medications efficacy also included lifestyle interventions and had high dropout rates in both control and intervention groups.

For more information about obesity medications refer to Nutrition Guideline: Adult Obesity Care.

Is glucose monitoring required for individuals with prediabetes?

Glucose monitoring is generally not required for someone with prediabetes.[80] Some individuals, however, may wish to obtain information about their own glycemic management to determine if they are in the normal, IFG and/or IGT range. They may wish to know about how their body responds to different food choices or physical activity in order to modify behaviours or to reinforce appropriate food and lifestyle choices.

Additional Considerations

Return to Key Questions List

How can I support a person with prediabetes facing financial strain and household food insecurity?

Household food insecurity (HFI) is defined as "an inadequate or insecure access to food because of financial constraints";[81] it impacts physical, mental and social well-being. HFI is higher among individuals living with diabetes compared to those without diabetes.[82] Providers will encounter patients living in food-insecure households due to the high prevalence of HFI among those accessing health care.[83]

HFI is best addressed through income-based interventions.[81,84,85] Those experiencing HFI have food preparation, budgeting, and cooking skills similar to the general population.[86] Interventions focused on food skills do not protect people from, nor improve HFI.[86] Emergency food programs (e.g. food banks) may provide temporary relief;[87] however, these programs do not solve HFI and are inappropriate and/or inaccessible for many patients.[87]

Healthcare providers can offer better support if they are aware when patients are worried about having enough money for food and are experiencing other challenges because of financial strain.[88,89] Providers are encouraged to work with patients to develop interventions that are sensitive to financial strain.

Key steps for healthcare providers include:

- Learn about financial strain, how to screen patients for poverty, and the link between poverty and poorer health through the **Identifying Financial Strain and Addressing Financial Barriers to Health Care Modules**; available on MyLearningLink for AHS staff and on CLiC for Covenant Health staff.
- Review the Nutrition Guideline: Household Food Insecurity for additional information on how to support patients experiencing HFI.
- Assist patients in accessing available income supports. 211 Alberta (ab.211.ca) is a provincial directory that can be used to identify financial benefits, programs, and services.

Resources

Return to Key Questions List

What resources are available for patients?

- Nutrition handouts are available for patients on a variety of topics to help support their learning needs and nutrition goals. Visit Nutrition Education Handouts for more information.
- Additional patient resources can be found at:
  - MyHealthAlberta https://myhealth.alberta.ca/
  - Diabetes Canada: www.diabetes.ca
  - Canada's food guide: www.healthcanada.gc.ca/foodguide
  - Glycemic index: www.glycemicindex.com

What resources are available for health professionals?

- Nutrition Guidelines are available on a variety of topics to help support health professionals provide consistent, evidence-based messaging. Visit Nutrition Education Handouts for more information.
- Additional resources for health professionals:
  - Diabetes Canada's Clinical Practice Guidelines provides diabetes practice support tools for Health Care Providers: Diabetes Canada | Clinical Practice Guidelines
  - Canadian Physical Activity Guidelines: www.csep.ca/guidelines

References

1. Punthakee Z, Goldenberg R, Katz P DCCPGEC. Definition, Classification and Diagnosis of Diabetes, Prediabetes and Metabolic Syndrome - PubMed [Internet]. [cited 2020 Jun 3]. Available from: https://pubmed.ncbi.nlm.nih.gov/29650080/
2. Heianza Y, Arase Y, Fujihara K, Tsuji H, Saito K, Hsieh SD, et al. Screening for pre-diabetes to predict future diabetes using various cut-off points for HbA(1c) and impaired fasting glucose: the Toranomon Hospital Health Management Center Study 4 (TOPICS 4). Diabet Med [Internet]. 2012 Sep [cited 2022 Jul 19];29(9). Available from: https://pubmed.ncbi.nlm.nih.gov/22510023/
3. Prebtani A, Bajaj HS, Goldenberg R, Mullan Y. Diabetes Canada | Clinical Practice Guidelines - Chapter 5: Reducing the Risk of Developing Diabetes [Internet]. Can J Diabetes. 2018 [cited 2020 Aug 14]. p. S20:26. Available from: http://guidelines.diabetes.ca/cpg/chapter5
4. Glechner A, Keuchel L, Affengruber L, Titscher V, Sommer I, Matyas N, et al. Effects of lifestyle changes on adults with prediabetes: A systematic review and meta-analysis. Vol. 12, Primary Care Diabetes. Elsevier Ltd; 2018. p. 393–408.
5. Ekoe MJ, Goldenberg R, Katz P. Diabetes Canada 2018 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada: Screening for Diabetes in Adults. Can J Diabetes. 2018;42(Suppl 1):S16–9.
6. Moller DE, Flier JS. Insulin Resistance — Mechanisms, Syndromes, and Implications. http://dx.doi.org/101056/NEJM199109263251307 [Internet]. 2010 Jan 14 [cited 2022 Jul 20];325(13):938–48. Available from: https://www.nejm.org/doi/full/10.1056/NEJM199109263251307
7. Huang Y, Cai X, Mai W, Li M, Hu Y. Association between prediabetes and risk of cardiovascular disease and all cause mortality: systematic review and meta-analysis. BMJ [Internet]. 2016 [cited 2022 Jul 20];355. Available from: /pmc/articles/PMC5121106/
8. Feldman AL, Long GH, Johansson I, Weinehall L, Fhärm E, Wennberg P, et al. Change in lifestyle behaviors and diabetes risk: Evidence from a population-based cohort study with 10 year follow-up. Int J Behav Nutr Phys Act [Internet]. 2017 Mar 29 [cited 2022 Jul 20];14(1):1–10. Available from: https://ijbnpa.biomedcentral.com/articles/10.1186/s12966-017-0489-8
9. Knowler W, Barrett-Connor E, Fowler S, Hamman R, Lachin J, Walker E, et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med [Internet]. 2002 Feb 7 [cited 2022 Jul 20];346(6):393–403. Available from: https://pubmed.ncbi.nlm.nih.gov/11832527/
10. Simmons RK, Harding AH, Jakes RW, Welch A, Wareham NJ, Griffin SJ. How much might achievement of diabetes prevention behaviour goals reduce the incidence of diabetes if implemented at the population level? Diabetologia [Internet]. 2006 May 1 [cited 2022 Jul 20];49(5):905–11. Available from: https://link.springer.com/article/10.1007/s00125-006-0163-1
11. Sievenpiper JL, Chan CB, Dworatzek PD, Freeze C, Williams SL. Diabetes Canada 2018 Clinical

Practice Guidelines for the Prevention and Management of Diabetes in Canada: Nutrition therapy. Can J Diabetes. 2018;42(Suppl 1):S64–79.

12. Evert AB, Dennison M, Gardner CD, Timothy Garvey W, Karen Lau KH, MacLeod J, et al. Nutrition therapy for adults with diabetes or prediabetes: A consensus report [Internet]. Vol. 42, Diabetes Care. American Diabetes Association Inc.; 2019 [cited 2020 Sep 10]. p. 731–54. Available from: https://doi.org/10.2337/dci19-0014
13. Esposito K, Chiodini P, Maiorino MI, Bellastella G, Panagiotakos D, Giugliano D. Which diet for prevention of type 2 diabetes? A meta-analysis of prospective studies. Endocrine [Internet]. 2014 [cited 2020 Oct 20];47(1):107–16. Available from: https://pubmed.ncbi.nlm.nih.gov/24744219/
14. Government of Canada, Health Canada. Canada's Food Guide [Internet]. [cited 2020 May 7]. Available from: https://food-guide.canada.ca/en/
15. Esposito K, Maiorino MI, Bellastella G, Chiodini P, Panagiotakos D, Giugliano D. A journey into a Mediterranean diet and type 2 diabetes: a systematic review with meta-analyses. BMJ Open [Internet]. 2015 Aug 1 [cited 2022 Jul 20];5(8):e008222. Available from: https://bmjopen.bmj.com/content/5/8/e008222
16. St-Onge M-P, Ard J, Baskin ML, Chiuve SE, Johnson HM, Kris-Etherton P, et al. Meal Timing and Frequency: Implications for Cardiovascular Disease Prevention: A Scientific Statement From the American Heart Association. Circulation. 2017;135(9):e96–121.
17. Diabetes Canada. The Balanced Food Plate [Internet]. 2021. Available from: http://guidelines.diabetes.ca/docs/patient-resources/The_Balanced_Food_Plate_EN.pdf
18. Diabetes Canada. Just the basics [Internet]. 2018. Available from: http://guidelines.diabetes.ca/docs/patient-resources/just-the-basics-EN.pdf
19. Institute of Medicine: Food and Nutrition Board. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids [Internet]. Washington (DC): Institute of Medicine of the National Academies; 2005. 7 p. Available from: https://www.nap.edu/read/10490/chapter/2
20. Ludwig DS, Hu FB, Tappy L, Brand-Miller J. Dietary carbohydrates: role of quality and quantity in chronic disease. BMJ. 2018;361:k2340.
21. Dietitians of Canada. Diet Composition – Ketogenic Diet. In: Practice-based Evidence in Nutrition [PEN]. [Internet]. 2018 [cited 2022 May 6]. Available from: Access only by subscription.
22. Feinman RD, Pogozelski WK, Astrup A, Bernstein RK, Fine EJ, Westman EC, et al. Dietary carbohydrate restriction as the first approach in diabetes management: critical review and evidence base. Nutrition. 2015 Jan;31(1):1–13.
23. Barnes T. Diabetes Canada Position Statement on Low-Carbohydrate Diets for Adults With Diabetes: A Rapid Review. Can J Diabetes. 2020 Jun 1;44(4):295–9.
24. Kirkpatrick CF, Bolick JP, Kris-Etherton PM, Sikand G, Aspry KE, Soffer DE, et al. Review of current evidence and clinical recommendations on the effects of low-carbohydrate and very-low-carbohydrate (including ketogenic) diets for the management of body weight and other cardiometabolic risk factors: A scientific statement from the National Lipid Association Nutrition and Lifestyle Task Force. J Clin Lipidol. 2019 Sep 1;13(5):689-711.e1.
25. Gupta L, Khandelwal D, Kalra S, Gupta P, Dutta D, Aggarwal S. Ketogenic diet in endocrine disorders: Current perspectives. J Postgrad Med. 2017;63(4):242–51.
26. Feig DS, Berger H, Donovan L, Godbout A, Kader T, Keely E, et al. Diabetes Canada 2018 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada: Diabetes and Pregnancy. Can J Diabetes. 2018;42(Suppl 1):S255–82.
27. Augustin LSA, Kendall CWC, Jenkins DJA, Willett WC, Astrup A, Barclay AW, et al. Glycemic index, glycemic load and glycemic response: An International Scientific Consensus Summit from

the International Carbohydrate Quality Consortium (ICQC). Nutr Metab Cardiovasc Dis [Internet]. 2015 Sep 1 [cited 2020 Oct 20];25(9):795–815. Available from: https://pubmed.ncbi.nlm.nih.gov/26160327/

28. Bhupathiraju SN, Tobias DK, Malik VS, Pan A, Hruby A, Manson JE, et al. Glycemic index, glycemic load, and risk of type 2 diabetes: results from 3 large US cohorts and an updated meta-analysis. Am J Clin Nutr [Internet]. 2014 Jul 1 [cited 2022 Jul 20];100(1):218–32. Available from: https://academic.oup.com/ajcn/article/100/1/218/4576511

29. Livesey G, Taylor R, Livesey HF, Buyken AE, Jenkins DJA, Augustin LSA, et al. Dietary Glycemic Index and Load and the Risk of Type 2 Diabetes: A Systematic Review and Updated Meta-Analyses of Prospective Cohort Studies. Nutr 2019, Vol 11, Page 1280 [Internet]. 2019 Jun 5 [cited 2022 Jul 20];11(6):1280. Available from: https://www.mdpi.com/2072-6643/11/6/1280/htm

30. Diabetes Canada. Glycemic index food guide [Internet]. 2018 [cited 2022 May 6]. Available from: http://guidelines.diabetes.ca/docs/patient-resources/glycemic-index-food-guide.pdf

31. Dahl WJ, Stewart ML. Position of the Academy of Nutrition and Dietetics: Health Implications of Dietary Fiber. J Acad Nutr Diet. 2015;115(11):1861–70.

32. Health Canada. Canada's dietary guidelines for health professionals and policy makers [Internet]. Ottawa, Canada: Her Majesty the Queen in Right of Canada; 2019. Available from: https://food-guide.canada.ca/en/guidelines/

33. Mela DJ, MWoolner E. Perspective: Total, added, or free? What kind of sugars should we be talking about? Adv Nutr [Internet]. 2018 Mar 1 [cited 2020 Oct 15];9(2):63–9. Available from: /pmc/articles/PMC5916432/?report=abstract

34. World Health Organization. Guideline: sugars intake for adults and children [Internet]. 2005 [cited 2020 Jun 9]. Available from: https://www.who.int/publications/i/item/9789241549028

35. Health Canada. Canadian Nutrient File (CNF) [Internet]. 2021. Available from: https://food-nutrition.canada.ca/cnf-fce/index-eng.jsp

36. Health Canada. Sugar Substitutes [Internet]. 2004 [cited 2022 Jun 16]. Available from: https://www.canada.ca/en/health-canada/services/food-nutrition/food-safety/food-additives/sugar-substitutes.html

37. Ashwell M, Gibson S, Bellisle F, Buttriss J, Drewnowski A, Fantino M, et al. Expert consensus on low-calorie sweeteners: facts, research gaps and suggested actions. Nutr Res Rev [Internet]. 2019 [cited 2020 Nov 6];33:145–54. Available from: https://doi.org/10.1017/S0954422419000283

38. Fitch C, Keim KS. Position of the Academy of Nutrition and Dietetics: use of nutritive and nonnutritive sweeteners. J Acad Nutr Diet. 2012 May;112(5):739–58.

39. Diabetes Canada. Sugar and Sweeteners [Internet]. Vol. 2018. 2018. Available from: http://guidelines.diabetes.ca/docs/patient-resources/sugars-and-sweeteners.pdf http://guidelines.diabetes.ca/docs/patient-resources/sugars-and-sweeteners.pdf

40. US Food & Drug Administration. High-Intensity Sweeteners | FDA [Internet]. 2014 [cited 2022 Jul 6]. Available from: https://www.fda.gov/food/food-additives-petitions/high-intensity-sweeteners

41. Health Canada. Consultation document on Health Canada's proposal to enable the use of a new food additive, monk fruit extract (luo han guo extract), as a sweetener in table-top sweeteners [Internet]. 2013. Available from: https://www.canada.ca/en/health-canada/services/food-nutrition/public-involvement-partnerships/notice-proposal-enable-use-new-food-additive-monk-fruit-extract-extract-sweetener-table-top-sweeteners/consultation.html

42. Dietitians of Canada. Diabetes - Sweeteners - Practice Questions. In: Practice-based Evidence in Nutrition [PEN] [Internet]. [cited 2022 Jul 6]. Available from: Access by subscription only.

43. Health Canada. Minister Petitpas Taylor announces Government of Canada ban on partially hydrogenated oils (PHOs)—the main source of industrially produced trans fats in Canadian food

[Internet]. Vol. 2018. 2017. Available from: https://www.canada.ca/en/health-canada/news/2017/09/minister_petitpastaylorannouncesgovernmentofcanadabanonindustria.html

44. Hooper L, Martin N, Abdelhamid A, G DS. Reduction in saturated fat intake for cardiovascular disease (Review) SUMMARY OF FINDINGS FOR THE MAIN COMPARISON. Cochrane Database Syst Rev. 2015;(6).

45. Fenton T, Royall D. Evidence Clip: Butter, margarine, saturated and trans fats – making sense of research reported in the news. Dietitians of Canada. 2015.

46. Leung AA, Daskalopoulou SS, Dasgupta K, Mcbrien K, Butalia S, Zarnke KB, et al. Hypertension Canada's 2017 Guidelines for Diagnosis, Risk Assessment, Prevention, and Treatment of Hypertension in Adults. Can J Cardiol [Internet]. 2017 [cited 2022 Jul 20];33:557–76. Available from: http://dx.doi.org/10.1016/j.cjca.2017.03.005

47. Nerenberg KA, Zarnke KB, Leung AA, Dasgupta K, Butalia S, McBrien K, et al. Hypertension Canada's 2018 Guidelines for Diagnosis, Risk Assessment, Prevention, and Treatment of Hypertension in Adults and Children. Can J Cardiol. 2018;34(5):506–25.

48. Dietitians of Canada. Cardiovascular Disease – Hypertension: Practice Guidance Toolkit. In: Practice-based Evidence in Nutrition [PEN] [Internet]. 2020. Available from: http://www.pennutrition.com

49. Young LR, Nestle M. Expanding portion sizes in the US marketplace: Implications for nutrition counseling. J Am Diet Assoc. 2003 Feb 1;103(2):231–40.

50. Ello-Martin JA, Ledikwe JH, Rolls BJ. The influence of food portion size and energy density on energy intake: implications for weight management. Am J Clin Nutr [Internet]. 2005 Jul 1 [cited 2022 Jul 20];82(1):236S-241S. Available from: https://academic.oup.com/ajcn/article/82/1/236S/4863399

51. Pittas AG, Dawson-Hughes B, Sheehan P, Ware JH, Knowler WC, Aroda VR, et al. Vitamin D Supplementation and Prevention of Type 2 Diabetes. N Engl J Med [Internet]. 2019 Aug 8 [cited 2022 Jul 20];381(6):520–30. Available from: https://www.nejm.org/doi/10.1056/NEJMoa1900906

52. Aloia JF. The 2011 Report on Dietary Reference Intake for Vitamin D: Where Do We Go From Here? J Clin Endocrinol Metab [Internet]. 2011 Oct 1 [cited 2022 Jul 20];96(10):2987–96. Available from: https://academic.oup.com/jcem/article/96/10/2987/2834833

53. Dong JY, Xun P, He K, Qin LQ. Magnesium Intake and Risk of Type 2 DiabetesMeta-analysis of prospective cohort studies. Diabetes Care [Internet]. 2011 Sep 1 [cited 2022 Jul 20];34(9):2116–22. Available from: https://diabetesjournals.org/care/article/34/9/2116/38612/Magnesium-Intake-and-Risk-of-Type-2-DiabetesMeta

54. Gröber U, Schmidt J, Kisters K. Magnesium in Prevention and Therapy. Nutrients [Internet]. 2015 Sep 23 [cited 2022 Jul 20];7(9):8199. Available from: /pmc/articles/PMC4586582/

55. Anderson TJ, Grégoire J, Pearson GJ, Barry AR, Couture P, Dawes M, et al. 2016 Canadian Cardiovascular Society Guidelines for the Management of Dyslipidemia for the Prevention of Cardiovascular Disease in the Adult. Can J Cardiol. 2016;32(11):1263–82.

56. Pearson GJ, Thanassoulis G, Anderson TJ, Barry AR, Couture P, Dayan N, et al. 2021 Canadian Cardiovascular Society Guidelines for the Management of Dyslipidemia for the Prevention of Cardiovascular Disease in Adults. Can J Cardiol. 2021;37(8):1129–50.

57. Grossman LD, Bscpharm RR, Shack Bfa AR. Complementary and Alternative Medicine for Diabetes. 2018 Clinical Practice Guidelines. 2018 [cited 2020 Aug 18]; Available from: https://doi.org/10.1016/j.jcjd.2017.10.023

58. Medagama AB. The glycaemic outcomes of Cinnamon, a review of the experimental evidence and clinical trials. Nutr J [Internet]. 2015 Oct 16 [cited 2022 Jul 20];14(1). Available from: /pmc/articles/PMC4609100/

59. Leach MJ, Kumar S. Cinnamon for diabetes mellitus. Cochrane Database Syst Rev [Internet]. 2012 Sep 12 [cited 2022 Jul 20];2017(12). Available from: https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD007170.pub2/full

60. Butt P Gliksman L, Paradis C, Stockwell T. BD. Alcohol and health in Canada: a summary of evidence and guidelines for low-risk drinking. Ottawa, ON: Canadian Centre on Substance Abuse; 2011.

61. Howard AA, Arnsten JH, Gourevitch MN. Effect of Alcohol Consumption on Diabetes Mellitus: A Systematic Review. Vol. 140, Annals of Internal Medicine. American College of Physicians; 2004.

62. Rabi DM, McBrien KA, Sapir-Pichhadze R, Nakhla M, Ahmed SB, Dumanski SM, et al. Hypertension Canada's 2020 Comprehensive Guidelines for the Prevention, Diagnosis, Risk Assessment, and Treatment of Hypertension in Adults and Children. Can J Cardiol. 2020;36(5):596–624.

63. Natella F, Scaccini C. Role of coffee in modulation of diabetes risk [Internet]. Vol. 70, Nutrition Reviews. Oxford Academic; 2012 [cited 2020 Nov 10]. p. 207–17. Available from: https://academic.oup.com/nutritionreviews/article/70/4/207/1936945

64. Van Dam RM. Coffee and type 2 diabetes: From beans to beta-cells [Internet]. Vol. 16, Nutrition, Metabolism and Cardiovascular Diseases. Elsevier; 2006 [cited 2020 Nov 10]. p. 69–77. Available from: https://pubmed.ncbi.nlm.nih.gov/16399494/

65. Tuomilehto J, Hu G, Bidel S, Lindström J, Jousilahti P. Coffee Consumption and Risk of Type 2 Diabetes Mellitus among Middle-aged Finnish Men and Women. J Am Med Assoc [Internet]. 2004 Mar 10 [cited 2020 Nov 10];291(10):1213–9. Available from: https://pubmed.ncbi.nlm.nih.gov/15010442/

66. Van Dam RM, Willett WC, Manson JAE, Hu FB. Coffee, caffeine, and risk of type 2 diabetes: A prospective cohort study in younger and middle-aged U.S. women. Diabetes Care [Internet]. 2006 [cited 2020 Nov 10];29(2):398–403. Available from: https://pubmed.ncbi.nlm.nih.gov/16443894/

67. Health Canada. Caffeine in food [Internet]. 2012 [cited 2022 Jun 16]. Available from: https://www.canada.ca/en/health-canada/services/food-nutrition/food-safety/food-additives/caffeine-foods/foods.html

68. Wharton S, Pedersen S, Lau D, Sharma A. Diabetes Canada | Clinical Practice Guidelines - Chapter 17: Weight Management in Diabetes [Internet]. 2018 [cited 2020 Aug 18]. Available from: http://guidelines.diabetes.ca/cpg/chapter17

69. Health Canada. Canadian guidelines for body weight classification in adults: Quick reference tool for professionals. Heal Canada [Internet]. 2016; Available from: http://www.hc-sc.gc.ca/fn-an/nutrition/weights-poids/guide-ld-adult/cg_quick_ref-ldc_rapide_ref-eng.php

70. Diabetes Prevention Program Research Group. 10-year follow-up of diabetes incidence and weight loss in the Diabetes Prevention Program Outcomes Study. Lancet. 2009 Nov 14;374(9702):1677–86.

71. Freedhoff Y, Sharma AM. Best Weight (Guidebook for Health Professionals) - Obesity Canada [Internet]. 2010 [cited 2022 Jul 12]. Available from: https://obesitycanada.ca/publications/best-weight-book/

72. Canadian Society of Exercise Physiology. 24-Hour Movement Guidelines – Canadian 24-Hour Movement Guidelines [Internet]. 2021 [cited 2022 Jul 6]. Available from: https://csepguidelines.ca/

73. Colberg SR, Sigal RJ, Yardley JE, Riddell MC, Dunstan DW, Dempsey PC, et al. Physical Activity/Exercise and Diabetes: A Position Statement of the American Diabetes Association. Diabetes Care [Internet]. 2016 [cited 2020 Nov 18];39:2065–79. Available from: http://www.diabetesjournals

74. Diabetes Canada. Physical activity and diabetes. 2018;

75. Aroda VR, Edelstein SL, Goldberg RB, Knowler WC, Marcovina SM, Orchard TJ, et al. Long-term metformin use and vitamin B12 deficiency in the diabetes prevention program outcomes study. J Clin Endocrinol Metab [Internet]. 2016 Apr 1 [cited 2020 Nov 12];101(4):1754–61. Available from: /pmc/articles/PMC4880159/?report=abstract

76. American Diabetes Association. 3. Prevention or delay of type 2 diabetes: Standards of medical care in diabetesd2020 [Internet]. Vol. 43, Diabetes Care. American Diabetes Association Inc.; 2020 [cited 2020 Nov 20]. p. S32–6. Available from: https://doi.org/10.2337/dc20-S003

77. Canadian Pharmacists Association. Compendium of pharmaceuticals and specialties, Online Version [e-CPS] [Internet]. Toronto: Canadian Pharmaceutical Association; 2015. Available from: www.e-therapeutics.ca

78. Lipscombe L, Booth G, Butalia S, Dasgupta K, Eurich DT, Goldenberg R, et al. Pharmacologic Glycemic Management of Type 2 Diabetes in Adults. Can J Diabetes [Internet]. 2018 Apr 1 [cited 2020 Aug 14];42:S88–103. Available from: https://pubmed.ncbi.nlm.nih.gov/29650116/

79. Pedersen S, Manjoo P, Wharton S. Pharmacotherapy in Obesity Management - Obesity Canada [Internet]. Canadian Adult Obesity Clinical Practice Guidelines. 2020 [cited 2022 Jul 18]. Available from: https://obesitycanada.ca/guidelines/pharmacotherapy/

80. Berard LD, Siemens R, Pharm B, Woo V. 2018 Clinical Practice Guidelines: Monitoring Glycemic Control. 2018 [cited 2020 Aug 13]; Available from: https://doi.org/10.1016/j.jcjd.2017.10.007

81. Tarasuk VS, Mitchell A. Household Food Insecurity in Canada, 2017-2018 - 2020 Toronto: Research to identify policy options to reduce food insecurity (PROOF) [Internet]. 2020 [cited 2021 Nov 29]. Available from: https://proof.utoronto.ca/resources/proof-annual-reports/household-food-insecurity-in-canada-2017-2018/

82. Gucciardi E, Vogt JA, DeMelo M, Stewart DE. Exploration of the Relationship Between Household Food Insecurity and Diabetes in Canada. Diabetes Care [Internet]. 2009 Dec 1 [cited 2022 Jul 6];32(12):2218–24. Available from: https://diabetesjournals.org/care/article/32/12/2218/25941/Exploration-of-the-Relationship-Between-Household

83. Men F, Gundersen C, Urquia ML, Tarasuk V. Food Insecurity Is Associated With Higher Health Care Use And Costs Among Canadian Adults. https://doi.org/101377/hlthaff201901637. 2020 Aug 3;39(8):1377–85.

84. Ontario Dietitians in Public Health. Position statement and recommendations on responses to food insecurity [Internet]. 2020. Available from: odph.ca.

85. Alberta Health Services. Household food insecurity evidence review: Lived experience and strategy effectiveness. Calgary; 2020.

86. Huisken A, Orr SK, Tarasuk V. Adults' food skills and use of gardens are not associated with household food insecurity in Canada. Can J Public Heal. 2016;107(6):e526–32.

87. Loopstra R, Tarasuk V. The relationship between food banks and household food insecurity among low-income Toronto Families. Can Public Policy. 2012;38(4):497–514.

88. Andermann A. Taking action on the social determinants of health in clinical practice: A framework for health professionals. CMAJ [Internet]. 2016 Dec 6 [cited 2022 Jul 5];188(17–18):E474–83. Available from: https://www.cmaj.ca/content/188/17-18/E474

89. Sivakumar G, Chau B. Poverty: A clinical instrument for family physicians. Univ West Ont Med J [Internet]. 2017 Dec 3 [cited 2022 Jul 6];86(2):62–4. Available from: https://ojs.lib.uwo.ca/index.php/uwomj/article/view/2045