

Nutrition Guideline

Calcium and Vitamin D for Prevention and Treatment of Osteoporosis

For Professional Reference Only

Applicable to: Nurses, Physicians and Other Health Professionals

This Nutrition Guideline is focused on adults who are at risk of, or who have osteoporosis. For information for the general healthy population, please refer to the *Nutrition Guideline: General Healthy Eating for Children and Adults*.

Recommendations

Calcium

- Adults at risk of or diagnosed with osteoporosis should include food sources of calcium and if needed, take a supplement to reach these intakes:
 - 19 to 50 years: 1000 mg per day from food and supplements combined.
 - Over 50 years: 1200 mg per day from food and supplements combined.

Vitamin D

- Adults at risk of or diagnosed with osteoporosis should include food sources of vitamin D in their diet and take a supplement each day.
- The 2010 Osteoporosis Society of Canada and Osteoporosis Canada and Alberta's Toward Optimized Practice (TOP) *Guideline for Diagnosis and Management of Osteoporosis*, Vitamin D supplement recommendations are:
 - Adults 19 to 50 years should take 400–1000 International Units (units) (10–25 micrograms [mcg]) vitamin D per day.
 - Adults 19 to 50 years with osteoporosis, multiple fractures or conditions affecting vitamin D absorption should take 800–2000 units (20–50 mcg) vitamin D per day.
 - Adults over 50 years should take 1000–2000 units (25–50 mcg) vitamin D per day.
 - To achieve optimal vitamin D status many adults may need up to 2000 units (50 mcg) per day.
- These recommendations apply in all areas of Alberta with no differentiation between northern and southern parts of the province.
- Blood tests for serum vitamin D levels are only recommended for adults at high risk of deficiency.

Health Benefits of Calcium and Vitamin D

- Calcium and vitamin D are needed for proper growth and maintenance of healthy bones and teeth. Adequate intakes help prevent and treat bone diseases such as rickets and osteoporosis.¹
- Calcium is also involved in vascular contraction and vasodilation, muscle contraction, nerve transmission, and the secretion of certain hormones and enzymes.^{2,3}

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- Vitamin D helps the body absorb and maintain normal serum levels of calcium and phosphorus to ensure normal mineralization of bone and to prevent hypocalcemia.⁴
- Calcium and vitamin D have been studied in relation to cancer (including colon and prostate cancer), cardiovascular disease, hypertension, diabetes, metabolic syndrome, weight management, falls and physical performance, immune function, autoimmune disorders, infections, neuropsychological function, and preeclampsia. Currently, there is not enough evidence to clearly establish the effects of calcium or vitamin D on these health conditions or to make recommendations about requirements to prevent or manage these conditions.^{3,4}

Key Questions

What are the risk factors for osteoporosis?

Risk factors for osteoporosis and osteoporotic fractures include:⁵

- older age
- sex
- low body weight
- low bone mineral density
- past fragility fracture
- having a parent who had a hip fracture
- a history of falls
- some medications and medical conditions increase risk by causing more thinning of bones, by increasing the risk of falls or both
 - Medications: synthetic glucocorticoids (e.g. prednisone), breast cancer drugs, prostate cancer drugs, “heartburn” drugs, Depo-Provera, excessive thyroid hormone replacement, anti-seizure and mood-altering drugs, blood pressure medication, diuretics, prostate drugs
 - Conditions that increase risk: rheumatoid arthritis, Crohn’s disease, ulcerative colitis, celiac disease, weight loss surgery, primary hyperparathyroidism, chronic kidney disease, chronic liver disease, type 1 diabetes, chronic obstructive pulmonary disease (COPD), untreated hyperthyroidism, neurological disorders

Osteoporosis Canada has an online tool that calculates risk: <https://osteoporosis.ca/risk/>

What dietary components can affect bone health?

Dietary components which are known to affect bone health include, but are not limited to:

Calcium and Vitamin D, which are covered in more detail in the following sections.

Overall diet: Eating a variety of healthy foods as recommended by Canada’s Food Guide will help provide adequate energy and protein to help people maintain a healthy weight. Low body weight (<60 kg) and major weight loss (10% below body weight at age 25) are risk factors for osteoporosis.⁶⁻⁸

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Protein: Protein is needed to build and repair bones. Not getting enough protein may lead to reduced muscle mass and strength, which can increase risk of falling.⁹ Adequate protein is important for treatment of osteoporotic bone fractures, and to help reduce risk of refracture.¹⁰

Though protein intakes above the RDA (the amount recommended for general health, 0.8 g/kg body weight per day) may be beneficial to bone health, more evidence is needed before recommendations can be established. Current evidence shows no adverse effects of higher protein intakes on bone health.^{11,12} Newer consensus recommends that all older adults (65 years and older) may need more protein (a minimum of 1.0-1.25 g/kg body weight per day) to maintain and regain muscle function and strength.⁹

Caffeine: Moderate daily caffeine intake up to 400 mg per day is not associated with any adverse effects on bone status and calcium balance in people with adequate calcium intake.⁷ Caffeine may induce a short-term increase in calcium excretion and may modestly decrease calcium absorption.²

Vegetables and Fruit: Eating vegetables and fruit everyday should be encouraged, though mechanisms for a benefit to bone health remain unclear.⁷

Alcohol: Chronic alcohol abuse is a significant risk factor contributing to osteoporosis and fracture. However, moderate alcohol consumption (1–2 drinks/day) is not harmful to bone health.⁷ One drink is 12 oz (355 mL) of beer, 5 oz (150 mL) of wine, or 1½ oz (45 mL) of liquor.

Sodium: Excess dietary sodium (more than 2300 mg per day) should be avoided as it may reduce bone mineral density.¹³

Vitamin B₁₂: Adequate intake of vitamin B₁₂ from food or supplements is recommended for older adults (>50 years) with low vitamin B₁₂ status, to help with bone formation.¹⁰

Refer to Guidelines: *Sodium; General Healthy Eating for Children, and Adults; Seniors Health Overview*

What are the results of calcium deficiencies?

- Simple dietary calcium deficiency usually has no symptoms, as calcium levels in the blood are tightly controlled.³
- Chronically low calcium intake or poor calcium absorption is one of the causes of decreased bone mineral density, osteoporosis (very low bone mineral density), and an increased risk of fractures.²
- Medical problems causing hypocalcemia produce symptoms such as numbness and tingling in fingers, muscle cramps, convulsions, lethargy, poor appetite and mental confusion.³

How much calcium do Albertans get from food?

The 2004 Canadian Community Health Survey reported that the average daily intake of calcium from food among Albertans, depending on age and gender, is 692 mg to 1297 mg.¹⁴ The only population groups that met the requirement for calcium intake from food are males ages 9 to 30, and females ages 19 to 30. Females over 70 years had the lowest intake of calcium from food – 692 mg per day; the RDA for this group is 1200 mg per day from food and supplements.¹⁴

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What are the calcium recommendations for adults who are at risk of or have Osteoporosis?

Try to meet calcium needs by eating food sources of calcium. Food sources have other important nutrients in them not found in supplements, like protein, fibre, and antioxidants. Adults who cannot meet their calcium needs with food sources should discuss supplement use with a health care provider.

Adults 19-50 years: The dietary reference intakes (DRIs) recommend a **total daily calcium intake of 1000 mg.**¹

Adults over the age of 50: Osteoporosis Canada (2010) and Alberta's Toward Optimized Practice (TOP) *Guideline for Diagnosis and Management of Osteoporosis*, (February 2016), recommend a **total daily calcium intake of 1200 mg.**⁸ This is higher than the DRI.

In the past, there have been questions about a possible link between calcium supplements and an increased risk of heart disease for adults (≥ 19 years). In 2016, the National Osteoporosis Foundation and American Society for Preventive Cardiology concluded, based on the available evidence, that calcium intakes from food and supplements within the tolerable upper limit (2000-2500 mg per day) are considered safe from a cardiovascular standpoint, in healthy adults.¹⁵

What are the food sources of calcium?

It's recommended to meet calcium needs by eating food sources of calcium. Food sources have other important nutrients in them not found in supplements, like protein, fibre, and antioxidants.

Table 1. Food sources of calcium (mg = milligrams)

Best sources About 300 mg of calcium	Good sources About 200 mg of calcium	Sources About 100 mg of calcium
<ul style="list-style-type: none"> Milk, lactose-reduced milk, and buttermilk, 1 cup (250 mL) Milk, evaporated, undiluted, ½ cup (125 mL) Skim milk powder, ⅓ cup (75 mL) Goat's milk, fortified 1 cup (250 mL) Fortified plant-based beverage such as soy, rice or almond, 1 cup (250 mL) Nutrition supplement drink* such as Boost® or Ensure®, 1 cup (250 mL) Hard cheese (cheddar, gouda, mozzarella, swiss), 1½ oz (50 g) Ricotta cheese, ½ cup (125 mL) Tofu made with calcium, ¾ cup (150 g) Plain yogurt, ¾ cup (175 mL) 	<ul style="list-style-type: none"> Flavoured yogurt, ¾ cup (175 mL) Camembert or feta cheese, 1 ½ oz (50 g) Dried smelt ½ oz (15 g) Kefir, ¾ cup (175 mL) Paneer**, 1 ½ oz (50 g) Parmesan cheese, ½ oz (15 g) Pudding made with milk, ½ cup (125 mL) Salmon, canned with bones, 2.5 oz (75 g) Sardines, canned with bones, 4 Soup made with milk, 1 cup (250 mL) Blackstrap molasses, 1 Tbsp (15 mL) 	<ul style="list-style-type: none"> Almonds, Brazil nuts, ¼ cup (60 mL) Almond butter, 2 Tbsp (30 mL) Calcium-fortified orange juice, ½ cup (125 mL) Chia seeds, 2 Tbsp (30 mL) Cottage cheese, ¾ cup (175 mL) Frozen yogurt, ½ cup (125 mL) Ice cream, ½ cup (125 mL) Raita, ⅓ cup (75 mL) Seaweed 1 cup (250 mL) Sesame butter (tahini), 2 Tbsp (30 mL) Skim milk powder, 1 Tbsp (15 mL) Bok choy, collard greens, or turnip greens, cooked, ½ cup (125 mL) White beans, navy beans, and soybeans, cooked, ¾ cup (175 mL)

Nutrient amounts from Canadian Nutrient File, 2015¹⁶

*Nutrient amounts from Nestle Health Science and Abbott Laboratories^{17,18}

**Nutrient amounts from Indian Food Composition Tables, 2017¹⁹

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What affects calcium absorption?

Foods rich in oxalic acid and phytic acid may inhibit calcium absorption; however, the total calcium content of the diet is more important for determining adequate intake than the bioavailability of calcium from specific foods.² Although high caffeine, protein, or sodium intakes may increase urinary losses of calcium, high intakes of these substances do not require increases in calcium intake.²

For people who eat a variety of foods, these interactions probably have little or no nutritional consequence and, furthermore, are accounted for in the calcium DRIs, which factor in differences in absorption of calcium in mixed diets.³

When are calcium supplements recommended?

It's recommended to meet calcium requirements from food sources when possible since foods provide a variety of nutrients that are not present in calcium supplements.²⁰ (See the 'Recommendations' section, and the 'What are the calcium recommendations for adults who are at risk of or have Osteoporosis?' section above.)

People who may be at risk of low calcium intakes include:³

- Postmenopausal women – decreased estrogen production results in increased bone resorption and decreased absorption of calcium.
- Amenorrheic women – amenorrhea (when menstrual periods stop or fail to start at the appropriate age) results from low levels of circulating estrogen. Low estrogen levels are occasionally due to anorexia nervosa or can be exercise-induced.
- People who eat little or no dairy products because of lactose intolerance, cow's milk allergy, or food preference.
- People who follow a vegan or vegetarian lifestyle and eat little or no dairy products.

A Registered Dietitian can help people improve their intake of calcium from food sources. People who are unable to meet their calcium needs with food sources should discuss supplement use with their health care provider.

Target total calcium intake from food and/or supplements should be 1000 mg for ages 19-50, and 1200 mg for over the age of 50. (See 'What are the calcium recommendations for adults who are at risk of or have Osteoporosis?' section above).

What are some recommendations for taking calcium supplements?

- Check the label of a supplement for:
 - The amount of *elemental calcium*. Elemental calcium is the amount of calcium that is actually provided by the supplement.
 - A Natural Product Number (NPN), Drug Information Number (DIN), or a Homeopathic Medicine Number (DIN-HM). These are 8-digit numbers assigned to products that have been assessed by Health Canada and found to be safe, effective and of high quality under their recommended conditions of use.^{21,22}

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- Calcium supplements are best absorbed when no more than 500 mg elemental calcium is taken at one time.³ For example, if you need to take 1000 mg calcium per day, split the dose and take 500 mg at two separate times in the day.
- Calcium can interfere with certain medications.²³ The Health Canada calcium monograph recommends taking calcium supplements a few hours before or after taking other medications.²⁴ Adults taking medication should talk with their pharmacist or physician about the best time of the day to take medications and/or supplement.
- Adults already taking a multivitamin or calcium supplement should check the amount of calcium it contains and then take a separate calcium supplement to obtain the rest. They should ensure they do not exceed upper limits for other vitamins and minerals. For example, taking more than one multivitamin daily can result in vitamin A levels above the tolerable upper limit.

Two of the most common forms of calcium supplements are calcium citrate and calcium carbonate.

- **Calcium carbonate** is commonly available and is less expensive. It is best absorbed when taken with food as gastric acid is needed for its absorption.³
- **Calcium citrate**³ can be taken any time. It is absorbed equally well when taken with or without food. Calcium citrate is often recommended for older populations because they may have lower amounts of gastric acid and gastric acidity is not needed for its absorption. Calcium citrate may also be useful for people with achlorhydria, inflammatory bowel disease, absorption disorders, or people taking proton pump inhibitors. Calcium citrate supplements are often more expensive than other calcium supplements.

The amount of elemental calcium in these two types of supplements is different. Calcium carbonate contains 40% calcium, while calcium citrate contains 21% calcium. This means that calcium citrate tablets often have lower amounts of elemental calcium, and so more tablets are needed to meet the daily dose.³

What are the risk factors for vitamin D deficiency?

Low intake of vitamin D – People with lactose intolerance or those who avoid dairy products may be at a higher risk of vitamin D deficiency if they do not take a daily vitamin D supplement.

Sun exposure – People who mostly stay or work indoors or live in the more northerly regions of Canada may not get enough sunlight to produce vitamin D.

Age – People over 50 years may not produce vitamin D in their skin as well as they did when they were younger.

Darker skin pigmentation – People with darker skin (more melanin) are less able to make vitamin D from being in the sun.

Medical conditions that interfere with absorption of vitamin D – Examples include Crohn's disease, cystic fibrosis, celiac disease, and some forms of liver disease.²⁵

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What are the results of vitamin D deficiencies?

- Vitamin D deficiency causes rickets, a condition characterized by soft and deformed bones, in children.²⁶
- Vitamin D deficiency can also lead to osteomalacia or osteoporosis in adults.⁴

How much vitamin D do Albertans get from food?

The 2004 Canadian Community Health Survey reported that the average daily intake of vitamin D from food by Alberta adults and children is 3.9 to 8.3 mcg (156 to 332 units) per day.¹⁴

Adequacy of vitamin D intake is difficult to assess because it is synthesized in the skin through sun exposure as well as being absorbed from food. The Institute of Medicine assumed minimal sun exposure when developing recommended intakes of vitamin D.¹

What are the vitamin D recommendations for adults who are at risk of or have osteoporosis?

Adults at risk of or diagnosed with osteoporosis should include food sources of vitamin D in their diet, and take a supplement each day.

The 2010 Osteoporosis Society of Canada and Osteoporosis Canada (2010) and Alberta's Toward Optimized Practice (TOP) *Guideline for Diagnosis and Management of Osteoporosis*, (February 2016), Vitamin D supplement recommendations are:^{6,8,27}

- Adults 19–50 years should take 400–1000 units (10–25 mcg) vitamin D per day.
- Adults 19–50 years with osteoporosis, multiple fractures or conditions affecting vitamin D absorption should take 800–2000 units (20–50 mcg) vitamin D per day.
- Adults over 50 years should take 1000–2000 units (25–50 mcg) vitamin D per day.
- To achieve optimal vitamin D status many adults may require up to 2000 units (50 mcg) per day.

These recommendations are higher than the DRIs but fall within the upper limit (4000 units (100 mcg) per day).

Adults should not exceed 4000 units (100 mcg) vitamin D per day unless advised and monitored by a physician.¹

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What are the food sources of vitamin D?

Food sources of vitamin D (mcg = micrograms)

Best sources More than 200 units (5 mcg) per serving	Good sources About 100 units (2 mcg) per serving	Sources About 50–100 units (1–2 mcg) per serving
<ul style="list-style-type: none"> • Fish, 2.5 oz (75 g)* <ul style="list-style-type: none"> ○ Arctic Char ○ Herring ○ Rainbow trout ○ Salmon 	<ul style="list-style-type: none"> • Milk and lactose-reduced milk, fortified with vitamin D, 1 cup (250 mL) • Milk, evaporated, undiluted, ½ cup (125 mL) • Fortified soy, rice or almond beverage, 1 cup (250 mL) • Skim milk powder, ⅓ cup (75 mL) • Fish, 2.5 oz (75 g)* <ul style="list-style-type: none"> ○ Sardines ○ Halibut 	<ul style="list-style-type: none"> • Margarine, 2 tsp (10 mL) • Eggs, 2 • Nutrition supplement drinks** such as Boost® or Ensure®, 1 cup (250 mL) • Mackerel, 2.5 oz (75 g)* • Canned tuna, 2.5 oz (75 g) • Yogurt, fortified with vitamin D, ¾ cup (175 mL)

Nutrient amounts from Canadian Nutrient File, 2015¹⁶

*Vitamin D levels in fish vary. For example, farmed salmon has less vitamin D than wild salmon

**Nutrient amounts from Nestle Health Science and Abbott Laboratories^{17,18}

Why is it recommended to take vitamin D supplements?

It is widely agreed that consuming adequate amounts of vitamin D from dietary sources is difficult.^{27,28} The 2004 Canadian Community Health Survey reported the average daily intake of vitamin D from food by Alberta adults and children is 3.9–8.3 mcg (156–332 units) per day.¹⁴

These intake levels mean that most Albertans get less than half of their recommended vitamin D requirements from food. Without supplementation of vitamin D, Albertans would be expected to make up the remaining vitamin D through unprotected sun exposure. In Canada, depending on the time of day, the time of year, how much skin is covered by clothing or sunscreen, and the degree of skin pigmentation, it may not be possible to achieve this degree of vitamin D synthesis.²⁷

According to the Guidelines Committee of the Scientific Advisory Council of Osteoporosis Canada, sunlight is inadequate to induce the synthesis of sufficient vitamin D during the winter at any latitude north of 35°N.²⁷ The entire province of Alberta is north of 45°N, therefore, there is little evidence to support differentiating between northern and southern parts of the province.

In view of low levels of vitamin D intake from food^{27,28} and probable low levels from sun exposure, **Nutrition Services, Alberta Health Services recommends vitamin D supplementation for Albertans.**

(See 'What are the calcium recommendations for adults who are at risk of or have Osteoporosis?' section above).

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What are some recommendations for taking a vitamin D supplement?

- Look for a Natural Product Number (NPN), Drug Information Number (DIN), or a Homeopathic Medicine Number (DIN-HM).
- Vitamin D supplements are available in two forms: vitamin D₂ or vitamin D₃. Both forms appear to be effective in maintaining serum vitamin D levels and improving bone health.^{4,29} Osteoporosis Canada recommends vitamin D₃ for vitamin D supplements.^{8,27}
- Vitamin D₂ is from non-animal sources and is appropriate for vegetarian or vegan diets.⁴
- Adults should not exceed 4000 units (100 mcg) vitamin D per day unless advised and monitored by a physician.¹
- If taking a multivitamin or calcium supplement, check the amount of vitamin D they contain. Take a separate vitamin D supplement to obtain the rest. Do not exceed upper limits for other vitamins and minerals. For example, taking more than one multivitamin daily can result in vitamin A levels above the tolerable upper limit.

Who should have their serum vitamin D level tested?

Not everyone needs their serum vitamin D level tested. The Institute of Medicine,¹ the Scientific Advisory Council of Osteoporosis Canada (2010),^{8,27} and the 2011 Endocrine Society Clinical Practice Guideline²⁹ state that it is unnecessary to do routine screening on those who are otherwise healthy.

Alberta's Toward Optimized Practice (TOP) *Guideline for Vitamin D Testing and Supplementation*, (October 2012), states that routine vitamin D testing is not warranted in the general population (those not at high risk of deficiency) and that testing is not necessary before or after starting vitamin D supplementation.³⁰

The TOP guideline lists the infrequent clinical situations where testing of serum 25-hydroxy vitamin D or serum 1, 25-dihydroxy vitamin D is indicated. Indications for serum 25-hydroxy vitamin D testing include significant renal and liver disease; osteomalacia, osteopenia or osteoporosis; malabsorption syndromes; hypo or hypercalcemia; hypo or hyperparathyroidism; medications affecting vitamin D metabolism.³⁰

The guideline lists further indications; it is available at: <http://topalbertadoctors.org/cpgs/28048723>

An Alberta Health Services Laboratory Bulletin (March 11, 2015) states that only vitamin D test requests meeting approved clinical criteria (metabolic bone diseases, abnormal blood calcium, malabsorption syndromes, chronic renal disease or chronic liver disease), submitted on the *Laboratory Services Vitamin D (25-Hydroxy) Requisition* form will be collected and processed.

www.albertahealthservices.ca/assets/wf/lab/wf-lab-bulletin-vitamin-d-availability.pdf

What are sources of calcium and vitamin D for people with lactose intolerance?

Lactose intolerance is the reduced ability to digest lactose, the sugar in milk and milk products.³¹ Lactose intolerance happens when low amounts of the enzyme lactase are produced. People with lactose intolerance differ in the amounts and types of lactose-containing foods they are able to tolerate.

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Tips to help people with lactose-intolerance get adequate calcium and vitamin D from their diet:³¹

- Spread the intake of milk and milk products throughout the day.
- Eat smaller amounts of milk and milk products at one time.
- Add lactase enzyme to food. The enzyme is available as pills or drops from pharmacies.
- Try milk that has had lactase enzyme added during processing. This milk is sold in most major grocery stores. Look for brands such as Lactaid® or Lacteeze®.
- Plant-based beverages (made from soy, almond, rice, etc) are naturally lactose free. Choose products fortified or enriched with calcium and vitamin D.
- Hard cheese is often better tolerated due to lower lactose levels.
- Yogurt contains lactose; however, bacterial cultures in yogurts that have active and live cultures convert lactose to lactic acid in the gut. Therefore, some people with lactose intolerance can tolerate yogurt with live cultures. Frozen yogurt does not contain bacterial cultures, so it may not be as well tolerated.

What can people do, besides improve their diet, to reduce prevent and manage osteoporosis?

Exercise improves quality of life (physical functioning and pain), muscle strength and balance of people with osteoporosis, although there is no conclusive evidence that it reduces fractures.⁸

The Osteoporosis Canada 2010 *Clinical Practice Guidelines for the Diagnosis and Management of Osteoporosis in Canada* recommends:⁸

- all adults over the age of 50 include regular active weight bearing exercise
- those with osteoporosis include weight bearing, balance and strengthening exercises
- those at risk of falls include exercises that focus on balance (e.g. tai chi), or on balance and gait training

The Osteoporosis Canada's *Too Fit to Fracture* recommends the following to adults with osteoporosis:³²

- strength training (such as weight lifting and exercises using resistance bands) at least 2 times per week
- posture exercises (such as standing and sitting with good posture, and yoga) every day
- balance training (such as Tai chi, dancing, and walking on your heels or toes) every day
- aerobic exercises (such as walking, dancing, and stair climbing) at least 150 min per week

Smoking cessation is recommended for prevention of osteoporosis. Smoking is a risk factor for osteoporosis-related fractures.⁶

Are there any handouts on calcium and vitamin D that I can use with my patients?

Refer to approved provincial Alberta Health Services nutrition handouts to support patient education. For more information, contact Nutrition.Resources@albertahealthservices.ca

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