

# Nutrition Guideline

## Restricted Carbohydrate in Chronic Disease Management

For Professional Reference Only

Applicable to: Nurses, Physicians, and Other Health Professionals

### Recommendations

- Well-planned restricted carbohydrate diets are one of many dietary approaches that can be implemented to achieve desirable metabolic and health outcomes.
- Restricted carbohydrate diets are often defined as:
  - *Moderately restricted carbohydrate* diets that provide at minimum 130 grams carbohydrate per day, but less than 45% of total energy from carbohydrate.
  - *Low carbohydrate diets* that restrict daily carbohydrate intake to less than 130 grams.
  - *Ketogenic diets* that are high in fat and very restricted in carbohydrate, providing less than 50 grams carbohydrate daily (i.e. 20 to 50 grams) to achieve nutritional ketosis.
- As carbohydrate amount decreases in the diet, the risk of nutrient deficiency increases.
- It is recommended that patients following a ketogenic diet be medically monitored.
- In people with diabetes, the use of a restricted carbohydrate diets can increase risk of hypoglycemia if diabetes medications are not adjusted or discontinued. The use of sodium-glucose co-transporter-2 (SGLT-2) inhibitors is of specific concern in people with diabetes following restricted carbohydrate diets due to increased risk of diabetic (euglycemic) ketoacidosis (DKA).
- Long-term adherence to any therapeutic diet can be challenging. If a patient is interested in following a restricted carbohydrate diet, it is recommended that health care providers discuss the patient's motivations and consider referring them to a Registered Dietitian for nutrition assessment and support.
- Short-term studies suggest the use of restricted carbohydrate diets may assist in weight reduction and improved glycemic control in the treatment of obesity and type 2 diabetes. High quality, longer-term studies are needed before recommending restricted carbohydrate diets as the preferred approach for long-term weight reduction, glycemic control, and reduction in cardiovascular risk markers.

For more information about dietary approaches for diabetes, cardiovascular disease, or weight management refer to the Nutrition Guidelines at <https://www.albertahealthservices.ca/info/Page15593.aspx>

### Description

The purpose of the *Restricted Carbohydrate Diets in Chronic Disease Management Nutrition Guideline* is to provide healthcare providers with an overview of the evidence and application of restricted carbohydrate diets, including ketogenic diets, for the management of adults with obesity, diabetes and/or cardiovascular disease.

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Diet is an important part of managing chronic health conditions such as obesity, diabetes, and cardiovascular disease (CVD). Research comparing higher carbohydrate diets ( $\geq 45\%$  total energy) with low (26 – 44% total energy) and very-low carbohydrate diets ( $< 26\%$  total energy) shows mixed results and has not demonstrated one intervention to be superior over the long term for weight loss, cardiovascular risk factors, and glycemic control in people with or without obesity and/or diabetes.<sup>1-6</sup> Therefore, well-planned restricted carbohydrate diets are one of many dietary approaches that may be used to achieve desirable metabolic and health outcomes. Registered Dietitians can help patients determine which dietary approach will best align with their lifestyle, health goals, preferences, culture and supports, to help manage their medical condition.

### Key Questions

Key nutrition questions related to restricted carbohydrate diets, including ketogenic diets are summarized below.

#### Definitions and Descriptions

- What are carbohydrates?
- What is the recommended daily intake of carbohydrates?
- What are restricted carbohydrate diets?
- What is a ketogenic diet?
- What is ketosis?
- What type of foods are included and limited/excluded in restricted carbohydrate diets?

#### Effectiveness

- What is the evidence to support the use of restricted carbohydrate diet in adults with obesity, diabetes and/or cardiovascular disease?
- What are important factors to consider for a patient thinking about following a restricted carbohydrate diet?

#### Safety Considerations

- What are the potential risks of following a restricted carbohydrate diet?
- Do patients require vitamin and mineral supplements when following a restricted carbohydrate diet?
- Do patients require medical monitoring while following a ketogenic diet?
- How are ketones monitored?
- How long is it safe for a patient to follow a ketogenic diet for?
- Are there any contraindications to following a ketogenic diet?
- What are the potential side effects that patients may experience when following a ketogenic diet?
- Are ketogenic diets safe in pregnancy?

#### Resources

- Where can I find more information about dietary management of obesity, diabetes or cardiovascular disease?

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## Definitions and Descriptions

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### What are carbohydrates?

Carbohydrates are typically the body's main source of energy. The main types of carbohydrate in the diet are starch, sugar, and fibre.

### What is the recommended daily intake of carbohydrates?

The recommended carbohydrate intake for healthy adults is based on scientific literature review, set by the Institute of Medicine, and used as a guideline to help assess and plan healthy diets.<sup>7</sup> A recommended daily allowance (RDA) and acceptable macronutrient distribution range (AMDR) are available for carbohydrate intake. See Table 1.

Among Canadian adults, just under 50% (46% for women and 48% for men) of daily energy intake comes from carbohydrates.<sup>8</sup>

Table 1 Recommendations for Daily Intake of Carbohydrate for Healthy Adults<sup>7</sup>

	RDA	AMDR
Description	The average daily carbohydrate intake that is sufficient to meet the requirements of 97-98% of the healthy adult population.	Percentage range of total energy intake derived from carbohydrate that has been associated with reduced risk of chronic disease while providing adequate intake of essential nutrients.
Recommendations	130 g 175 g (for pregnant women) 210 g (for lactating women)	45 – 65%

The amount of carbohydrate suggested for the management of obesity, diabetes, and cardiovascular disease depends on individual lifestyle and metabolic response. The amount and quality of carbohydrate (e.g. amount of fibre, added sugars, processing) is an important factor when considering dietary carbohydrate intake effect on health.<sup>9</sup>

### What are restricted carbohydrate diets?

The definition of restricted carbohydrate diets varies in the literature. Table 2 provides definitions and descriptions that are commonly used. *Moderately* restricted carbohydrate diets include the RDA of 130 grams carbohydrates per day, but provide less than the minimum carbohydrate AMDR (45% of total energy from carbohydrate). *Low* carbohydrate diets are typically defined as restricting carbohydrate intake to less than the 130 grams RDA for carbohydrate. *Ketogenic* diets restrict carbohydrate to less than 10% of total daily energy; as the carbohydrate intake reduces, the fat intake typically increases to levels above 70% of total daily energy intake.

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Table 2. Restricted Carbohydrate Diet Descriptions<sup>7,10,11</sup>

Diet	Carbohydrate Amount*
Moderate carbohydrate	at least 130 grams carbohydrate daily and between 26 to 45% total energy from carbohydrate.
Low carbohydrate	less than 130 grams carbohydrate daily or less than 26% total energy from carbohydrate.
Ketogenic (Very Low Carbohydrate High Fat <sup>†</sup> )	20 to 50 grams carbohydrate daily or less than 10% total energy from carbohydrate.

\*Note: Carbohydrate refers to available or net carbohydrate, which is the total carbohydrate minus dietary fibre.

<sup>†</sup>High Fat typically refers to an intake of 65 to 80% of total energy from dietary fat.

Some dietary approaches restrict the total amount of carbohydrate per day, other approaches restrict certain foods (e.g. food groups) or types of carbohydrate (e.g. refined grain products, added sugars, etc.). Generally, as the proportion of carbohydrate decreases, energy intake from dietary fat increases. Protein intake can vary as well, but tends to remain within the recommended range (10 – 35% of daily energy).<sup>7</sup> As the carbohydrate amount decreases in the diet, the risk of nutrient deficiency increases.<sup>12-14</sup>

### What is a ketogenic diet?

A ketogenic diet includes a very low carbohydrate and high fat intake for the purpose of promoting the body to use a higher proportion of fatty acids for energy and putting the body in a state of nutritional ketosis.<sup>15</sup> Most dietary patterns associated with ketosis focus on restricting carbohydrate intake to less than 50 grams per day with increased fat intake (65 – 80% of total daily energy).<sup>10</sup> Protein intake remains within recommended ranges (10 – 35% of total energy intake).<sup>7,10</sup> Fasting is also sometimes used to expedite the time required to enter into the ketosis state.

### What is ketosis?

**Nutritional or metabolic ketosis** often refers to the physiological state created due to a ketogenic diet.<sup>16,17</sup> Nutritional ketosis can occur after a period of time (typically 3 to 4 days) of following a very-low (less than 50 grams) carbohydrate intake.<sup>17</sup> Dietary carbohydrates provide the body with glucose, which is typically the body's primary source of fuel.<sup>7</sup> When the body's availability of glucose is low, ketones (acetoacetate, beta-hydroxybutyrate, acetone) are produced from fatty acids in the liver and can be used as an alternative fuel source.<sup>16</sup> The amount of time for the body to enter into the state of metabolic ketosis will depend on the dietary approach and individual factors (e.g. activity level, body size, etc.).

**Diabetic ketoacidosis (DKA)** differs from metabolic ketosis. It is a life threatening condition that occurs due to severe insulin deficiency and causes an acute rise in blood ketone concentrations, electrolyte imbalances, and acidosis.<sup>15,18</sup>

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### What type of foods are included and limited/excluded in restricted carbohydrate diets?

Table 3 provides a general overview of the foods included and excluded from restricted carbohydrate diets. The amounts from each category will vary depending on the diet approach used.

Table 3. Foods Included and Excluded in Restricted Carbohydrate Diets<sup>19</sup>

Included	Limited/Excluded
<b>Non-starchy vegetables (above ground):</b> <ul style="list-style-type: none"> <li>dark leafy greens</li> <li>Brussels sprouts</li> <li>cabbage</li> <li>broccoli</li> <li>cauliflower</li> </ul>	<b>Any grains or starches</b> <ul style="list-style-type: none"> <li>bread</li> <li>pastas</li> <li>potatoes</li> <li>rice</li> <li>oatmeal</li> <li>cereals</li> <li>crackers</li> <li>chips</li> </ul>
<b>Protein foods:</b> <ul style="list-style-type: none"> <li>eggs</li> <li>non—breaded meats</li> <li>fish</li> <li>poultry</li> <li>tofu</li> <li>nuts</li> <li>nut butters</li> <li>plain yogurt</li> <li>cheese</li> </ul>	<b>Fruit:</b> <ul style="list-style-type: none"> <li>all with the exception of occasional small amounts of berries</li> </ul>
<b>Fats:</b> <ul style="list-style-type: none"> <li>butter</li> <li>olive oil</li> <li>coconut oil</li> <li>avocado</li> <li>full-fat dairy products (e.g. sour cream, cream cheese)</li> </ul>	<b>High carbohydrate dairy products</b> <ul style="list-style-type: none"> <li>milk,</li> <li>yogurt with added sugar</li> </ul>
	<b>Fats:</b> <ul style="list-style-type: none"> <li>from highly processed oils/fats that also contain carbohydrate</li> </ul>
	<b>Added sugars</b> and sweetened beverages/foods

### Effectiveness

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### What is the evidence to support the use of restricted carbohydrate diet in adults with obesity, diabetes and/or cardiovascular disease?

Well-planned restricted carbohydrate diets are one of many dietary approaches that can be implemented to achieve desirable metabolic and health outcomes. In studies, restricted carbohydrate diets are often compared to lower-fat (<30% total energy) higher carbohydrate (>45% total energy) diets that may or may not be energy restricted. Study designs vary in size, duration, and overall design quality, and therefore, impact the findings.<sup>4,5</sup>

**Weight Reduction:** There is evidence to indicate that restricted carbohydrate are superior in the short-term (6 to 12 months) for weight reduction, but often there is no clinical difference in weight loss over the long-term (> 12 to 24 months) when compared to other dietary approaches. Mean weight loss achieved in randomized control studies ranges between 0.7 to 4.0 kg and is dependent on study quality and duration.<sup>4</sup>

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**Lipid Profile:** Studies comparing restricted carbohydrate/ketogenic diets to higher carbohydrate diets have demonstrated favorable increases in HDL cholesterol and reduction in triglycerides.<sup>4</sup> The effect on LDL cholesterol is mixed.<sup>4</sup> Due to lack of long-term trials, it is not possible to evaluate the impact of these diets on cardiovascular morbidity or mortality.<sup>20</sup>

**Blood Pressure:** The impact of restricted carbohydrate diets on blood pressure are not widely reported. There is some evidence to demonstrate that ketogenic diets may have a positive effect on diastolic blood pressure in adults with overweight or obesity.<sup>21</sup> It has been suggested that antihypertensive and diuretic medications may need to be reduced in people initiating a restricted carbohydrate diet.<sup>22</sup> Sodium restricted diets are not advised when patients follow a ketogenic diet due to the reduced resorption of sodium from the kidneys caused by lower levels of insulin action.<sup>22</sup> More research is needed to understand the long term impact of ketogenic diets on blood pressure.

**Type 2 Diabetes:** Studies in adults with type 2 diabetes have demonstrated that restricted carbohydrate diets produce greater reductions in A1c compared to higher carbohydrate diets in the short term, but no difference was observed in the longer term (12 to 24 months).<sup>5</sup> It is important to note that restricted carbohydrate diets often require a reduction in diabetes medications, so despite no difference in A1c in the long-term, the reduction in medications may be an important outcome to consider.<sup>5</sup>

**Type 1 Diabetes:** Research evaluating restricted carbohydrate diets in adults with type 1 diabetes is in its infancy.<sup>23</sup> A review of the evidence suggest that restricted carbohydrate diets may have a lowering effect on A1c and reduction in total daily insulin doses in people with type 1 diabetes.<sup>24</sup> Little is known about the effect of restricted carbohydrate diets on other important outcomes such as risk of severe hypoglycemia, weight, and glycemic variability.<sup>23,24</sup>

There are many gaps in the evidence to make conclusions about the long-term effects of restricted carbohydrate diets on other markers of health and chronic disease, such as inflammation and the gut microbiome.

### What are important factors to consider for a patient thinking about following a restricted carbohydrate/ketogenic diet?

Long-term adherence to any therapeutic diet can be challenging. If a patient is interested in following a restricted carbohydrate consider discussing the following with them:<sup>22,25</sup>

- Their personal health and lifestyle goals
- Readiness to make a lifestyle change
- Their knowledge about restricted carbohydrate or ketogenic diets
- Importance of focusing on behaviour change goals (e.g. eating more home prepared meals) rather than weight goals.
- Their expected outcomes related to following a restricted carbohydrate diet.
- Supports and resources available to make and sustain the change (e.g. family, friends, other healthcare providers, finances, time to learn new food preparation skills, etc.)
- Readiness to self-monitor and frequently communicate with healthcare providers for safe medication adjustments (e.g. for glucose, blood pressure, lipid and/or thyroid management).

Consider referring patients to a Registered Dietitian

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### Safety Considerations

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#### What are the potential risks of following a restricted carbohydrate diet?

Adverse effects of restricted carbohydrate diets are poorly reported in clinical trials.<sup>4</sup> Real and potential risks associated with restricted carbohydrate diets are summarized below.

**Nutrient deficiencies** can occur with any type of restricted diet. Nutrients of concern associated with restricted carbohydrate diets are listed in the question below. A nutrition assessment by a Registered Dietitian is recommended for patients following restricted carbohydrate diets.

**In people with diabetes**, hypoglycemia can occur if diabetes medications are not adjusted or discontinued.<sup>16</sup> Increased risk of diabetic (euglycemic) ketoacidosis (DKA) with the use of sodium-glucose co-transporter-2 (SGLT-2) inhibitors is of specific concern in people with diabetes.<sup>26</sup> It is also important to note that the response to glucagon treatment may be blunted in people with diabetes following a restricted carbohydrate diet.<sup>27</sup>

#### Do patients require vitamin and mineral supplements when following a restricted carbohydrate diet?

A well-planned restricted carbohydrate diet may not need vitamin and mineral supplementation beyond what is recommended for other dietary approaches.<sup>19</sup> The extent to which carbohydrate rich foods are restricted will determine the risk of vitamin/mineral deficiency and need for supplementation. A ketogenic diet excludes nutrient rich foods (e.g. whole grains and fruit) and poses the highest risk of nutrient deficiency among restricted carbohydrate diets. There are currently no evidence-based guidelines or protocols for vitamin and mineral supplementation while following a ketogenic diet for the treatment of obesity, diabetes or cardiovascular disease, but it is likely that some vitamin and mineral supplementation will be required.

The following are nutrients of concern related to ketogenic diets:<sup>16,28</sup>

- Fibre
- B-vitamins
- Folic Acid (women of child-bearing age)
- Vitamin A, D, K
- Calcium
- Potassium
- Magnesium
- Selenium
- Zinc

Consider referring patients following a restricted carbohydrate to a Registered Dietitian for an assessment of possible nutrient deficiencies.

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### Do patients require medical monitoring while following a ketogenic diet?

Medical monitoring of patients following a ketogenic diet is consistently recommended in the literature. Unfortunately, there is a lack of published evidence-based guidelines to support consistent practice in medical monitoring. Recommendations for medical monitoring should be discussed with the patient's physician and based on the patient's medical condition, risk factors, and expected goals/outcomes of the therapeutic diet intervention.

### How are ketones monitored?

Ketone monitoring is used as a biomarker of ketosis and diet adherence.<sup>29,30</sup> This can be achieved either using urine, capillary blood or breathalyzers (Table 4).

Table 4. Methods of Ketone Monitoring<sup>31</sup>

Urine Testing	Breathalyzer Testing	Blood Testing
<ul style="list-style-type: none"> <li>Least expensive method</li> <li>Less reliable as takes time for urine to collect and influenced by hydration</li> </ul>	<ul style="list-style-type: none"> <li>Doesn't always correlate to blood ketones</li> <li>Influenced by alcohol and water intake</li> <li>Lower long-term cost</li> </ul>	<ul style="list-style-type: none"> <li>Most accurate</li> <li>Requires finger prick for blood sample</li> <li>Most costly</li> </ul>

Normally blood concentrations of ketones are below 0.3 mmol/L.<sup>17</sup> Trials implementing ketogenic diets for the treatment of obesity or diabetes do not always report blood or urine ketone levels. In studies that do, blood ketone levels equivalent to approximately 0.5 mmol/L or urine dipstick levels indicating trace to small amounts are typically achieved.<sup>22,29,30</sup>

### How long is it safe for a patient to follow a ketogenic diet for?

The long-term (greater than 1 to 2 years) safety of ketogenic diets is difficult to determine due to lack of robust studies. If an individual has been following a ketogenic diet for an extended period of time and wishes to re-introduce more dietary carbohydrates, it is advisable to increase carbohydrate intake slowly over-time and monitor patient response.<sup>16</sup> Little is known about the effects intermittently including a higher carbohydrate intake while following a ketogenic diet, but consequences such as endothelium damage have been recognized.<sup>32</sup>

### Are there any contraindications to following a ketogenic diet?

Contraindications to following a ketogenic diet include:<sup>16</sup>

- Inborn errors of fat metabolism and enzyme deficiencies
- Renal stones (urolithiasis)
- Severe dyslipidemia\*
- Significant liver disease\*
- Failure to thrive
- Severe gastroesophageal reflux\*
- Poor oral intake
- Cardiomyopathy\*
- Chronic metabolic acidosis
- Pregnancy<sup>10</sup>

\*depend on severity of the condition as assessed by the patient's physician.

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### What are the potential side effects that patients may experience when following a ketogenic diet?

Side effects that may occur when initiating and following a ketogenic diet include:<sup>4,16</sup>

- headaches
- constipation
- diarrhea
- insomnia

### Are ketogenic diets safe in pregnancy?

Ketogenic diets are not recommended during pregnancy.<sup>10</sup> The safety of ketogenic diets in pregnancy has not been established and animal studies provide variable results on central nervous system and behaviour outcomes.<sup>33,34</sup>

### Resources

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### Where can I find more information about dietary management of obesity, diabetes or cardiovascular disease?

- Consult with a Registered Dietitian in your area.
- Refer to the other Nutrition Guidelines at <https://www.albertahealthservices.ca/info/Page3505.aspx>
- Refer to approved provincial Alberta Health Services nutrition handouts to support patient education. Information on Alberta Health Services website can be found here <https://www.albertahealthservices.ca/nutrition/Page11115.aspx>  
For more information, contact [Nutrition.Resources@albertahealthservices.ca](mailto:Nutrition.Resources@albertahealthservices.ca)

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