

FAQ #1 Sugar and Cancer

SCOPE:

This summary addresses cancer and added sugar and naturally occurring sugar as part of a diet providing typical carbohydrate levels (falling within the DRI of 45-65 % of total calories as carbohydrate).

This summary, where relevant, comments on but does not review evidence for the impact of low carbohydrate diets (diets providing carbohydrate levels below the DRI of 45% of total calories as carbohydrate), ketogenic diets or low glycemic load diets on cancer.

Background and Rationale:

It is a commonly held belief that eating sugar promotes the growth of cancer. As a result, many individuals with cancer remove sugar from their diets in an effort to slow or stop cancer growth. The notion that sugar is “bad” for individuals with cancer can cause significant distress and prompt dramatic dietary changes.

EVIDENCE:

Defining Carbohydrates and Sugar

- Carbohydrates are widespread in the food supply and are found in grain products, vegetables, fruits, milk, beans and lentils.
- The single sugar unit monosaccharides (glucose, fructose and galactose) are the building blocks for other carbohydrates. When two monosaccharide units are connected they form one of the three disaccharides (lactose, sucrose and maltose). These are sometimes called simple sugars. Polysaccharides (complex carbohydrates) are formed when multiple monosaccharide units are linked together. All simple sugars and complex carbohydrates are made from combinations of the 3 monosaccharides. For example, two glucose units linked together form sucrose (also known as table sugar).
- Sugars are also often classified as “added sugars” as in those added to foods (such as table sugar and as found in sugar sweetened beverages) or “naturally occurring” as found in fruit and milk.

Digestion Process

- Digestion occurs within the gastrointestinal tract and breaks foods into their building blocks for absorption.
- Table sugar (sucrose), honey, molasses and most other disaccharides and all polysaccharides (grains, beans, and legumes) are broken down into their component

monosaccharides and other nutrients in the small intestine. Monosaccharides are absorbed through the lining of the small intestine into portal circulation.

- Once in the blood stream, glucose is the same, whether it originated in food as an added sugar, as a naturally occurring sugar or from a polysaccharide.
 - Once in portal circulation, glucose, galactose and fructose are carried to the liver. Glucose is then either: stored in the liver as glycogen, put in the blood stream to maintain blood glucose levels or used by the liver for energy. Both fructose and galactose can be used as energy by the liver or can be converted to glucose derivatives, where they will have the same fate as glucose. Thus, to a cell, once in the blood stream monosaccharides are identical regardless of where they originated from.

Stabilizing Blood Glucose Levels

- Glucose is the preferred energy source for all cells in the body. To ensure cells receive a continuous supply of energy blood glucose levels are maintained within the range of approximately 4-6 mmol/L.
- Blood glucose levels are tightly controlled through the hormonal actions of insulin and glucagon.
- Blood glucose levels rise after eating carbohydrate containing foods, triggering the release of insulin. This, in turn, stimulates the uptake of glucose into cells for energy and the storage of glucose as glycogen in the liver and muscle. As the body uses and stores glucose, blood glucose levels return to their normal range.
- During times of fasting the body will release and produce glucose to maintain and regulate blood glucose levels.
- The main storage form of glucose in the body is glycogen; the body stores enough glycogen for about 1 day. During periods of fasting (including between meals) gluconeogenesis (the creation of glucose molecules from amino acids) in the liver maintains normal blood glucose concentrations. Gluconeogenesis will take place at the expense of muscle tissues. In longer term starvation, the body starts breaking down fat to form ketone bodies, which can be used to provide energy for most cells in the body, sparing glucose for the brain. This process allows the body to burn fat tissue while maintaining lean muscle mass.

Glycemic Index and Glycemic Load

- The glycemic index is a way to classify carbohydrates based on how quickly *a portion of food that has 50 grams of carbohydrate* will increase blood glucose levels. Foods that digest quickly such as a sugar sweetened beverages increase blood glucose levels faster than foods that digest more slowly.
- Glycemic load (GL) is another measure that accounts for how quickly *a typical portion* eaten will increase blood glucose levels.
- Foods with a higher GL would be expected to result in a greater increase in blood glucose and secretion of insulin compared to foods with a lower GL.
- Research suggests that there are links between frequently elevated blood glucose, blood insulin levels and obesity and chronic disease (Grooper, p77). This is of specific interest for cancer as insulin is an anabolic hormone and high insulin levels may create an environment

more conducive to cancer development by resulting in production of other cell growth factors and reducing cell death (Parekh). In a cohort study that assessed the link between sugar-sweetened beverages and recurrence of cancer and mortality in colon cancer patients, higher intake (2 or more servings daily equal to 355-mL) was related to increased recurrence. This association was seen for patients who were overweight and less physically active, but not in patients with a normal weight and who were physically active (Fuchs). This brings to question whether it is the consumption of sugar-sweetened beverages alone that is problematic or when in combination with specific conditions such as overweight, insulin resistance and high blood insulin levels. Our understanding of glycemic response, insulin, insulin receptors and the relationship of insulin to cancer is not fully understood.

- Neither a food's glycemic index nor glycemic load takes into account the consumption of foods as part of a mixed meal. Factors, such as fibre, protein and fat, in addition to the amount of carbohydrate in a meal, food ripeness, preparation and temperature as well as physical activity and individual glucose tolerance will impact glycemic response.
- The American Institute for Cancer research cancer prevention guidelines describe a healthier way to include sugar in the diet. is described in the guidelines established by. For cancer prevention and for anyone who has received a cancer diagnosis and does not require specialized nutrition intervention, a plant based whole food eating pattern that is low in added sugars and highly processed foods is recommended. This eating pattern naturally has a low glycemic load.

Non-Carbohydrate Factors of Dietary Carbohydrates that May Affect Cancer Risk or Progression

Teasing out the implications of added sugars on cancer risk/progression is complicated by compositional difference of dietary carbohydrates, including micronutrient, calorie, and fibre content.

- **Micronutrients:** In general, food and drinks with lots of added sugar do not provide many other nutrients. In contrast, whole foods and drinks with naturally occurring sugars tend also to be sources of other nutrients (IOM, 2005). Foods containing various micronutrients (for example, folate, carotenoids, beta-carotene, lycopene, vitamin C, and selenium) have been associated with a decrease in risk of cancer. Thus a diet high in added sugar may be low in the types of foods that are protective (e.g. vegetables and fruit). Fruits and vegetables, compared to foods with high amounts of added sugar, not only tend to be richer in micronutrients but lower in calorie density.
- **Caloric density:** Many calorically dense foods are high in added sugar. These foods are a potential source of excess calories and may lead to obesity which linked to increased cancer risk. Overweight and obesity is a risk factor for esophageal, pancreatic, colorectal, post-menopausal breast, endometrial, kidney and gallbladder cancers (WCRF/AICR, 2007) and is also related to increased risk of recurrence and cancer-related death (Ligibel).
 - Cancer prevention guidelines and guidelines from other health organizations encourage limits on added sugars (labeled as calorically dense foods) and sugary drinks for the purpose of preventing excess calorie intake which can lead to weight

gain and obesity risk factor for cancer and other chronic disease(WCRF/AICR, 2007 WHO, AHA).

- **Dietary Fibre:** Whole foods compared to foods high in added sugars tend to provide more dietary fibre. Dietary fibre provides health benefits by slowing digestion, helping with stool elimination and protecting the lining of the colon. Plant foods rich in dietary fibre help to protect against colon cancer. A diet high in added sugar may be one that is low in dietary fibre thus less cancer protective for this reason.

Conditions that May Affect Cancer Risk or Outcomes

- **Diabetes:** Type 2 diabetes is associated with risk for liver, pancreatic, colon, endometrial cancers and may also be related to postmenopausal breast cancer, bladder, kidney and non-Hodgkin lymphoma. It is unclear if type 2 diabetes directly increases cancer risk or if it is an indirect mechanism resulting from obesity, insulin resistance, inflammation and high blood sugars, conditions common in Type 2 diabetes (Collins).
- **Insulin Resistance:** With insulin resistance cells are less responsive to insulin thus the pancreas needs to produce more insulin to maintain normal blood glucose levels resulting in higher blood levels of insulin. Insulin is a hormone that causes cell growth. In addition to promoting cell growth high blood insulin levels may impact other factors that create an environment more conducive to cancer (Parekh).
- **Unintentional weight loss:** Maintaining a good nutrition status during treatment is related to fewer complications, ability to maintain treatment schedules and better quality of life (Leser, page 25). Malnutrition can negatively impact cancer outcomes by contributing to slowed healing, poor treatment tolerance, and delayed treatments (Leser, p25). Unintentional weight loss is a potential risks associated with decreasing sugar consumption. The degree to which sugar avoidance results in inadequate calorie intake and weight loss resulting in malnutrition is individual. It is not uncommon that cancer patients undergoing treatment will at some point during treatment experience malnutrition (Leser, p25).

Content Experts, Guidelines and Recommendations

- Content experts address the question, “Does sugar feed cancer?” in guidelines commissioned by the American Cancer Society. They conclude that “sugar intake has not been shown to directly increase risk or progression of cancer” While recognizing that “sugars... can promote weight gain, which adversely affects cancer outcomes” And that “foods and beverages that are high in added sugar do not contribute many nutrients to the diet and often replace more nutritious food choices. Therefore, limiting ... added sugar is recommended.” (Rock 2012, page 23)
- World Cancer Research Fund/American Institute for Cancer Research Report (2007) advocates that the consumption of foods containing added sugars be limited as a general goal for public health (WCRF/AICR, 2007). Specifically, stated is to limit energy-dense foods and avoid sugary drinks. Many of the diet and lifestyle factors that affect cancer risk may also impact cancer progression and recurrence. Cancer prevention guidelines encourage

limits on added sugars (labeled as calorically dense foods) for the purpose of preventing excess calorie intake which can lead to weight gain and obesity a cancer risk factor.

Ketogenic Diet

A ketogenic diet eliminates carbohydrates and depletes circulating glucose levels inducing ketosis while providing calories and protein to prevent starvation. A ketogenic diet eliminates or severely restricts fruits, juices, starchy vegetables including peas, many dairy foods, grains (bread, pasta, rice) in addition to all sugar-sweetened foods and added sugars. The diet is often deficient in many nutrients, requires skillful planning and monitoring with a medical team to ensure safety (Leser, 2013). From a mechanistic standpoint it is biologically more plausible to affect cancer progression than simply removing simple sugar (added and/or naturally occurring) from the diet, as normal cells have the capacity to shift to ketones as an alternate fuel source while cancer cells may not have this adaptive capacity. At this time it is not known if cancer outcomes are impacted by a ketogenic diet, but research including clinical trials are ongoing.

CONCLUSION:

All cells in the body including cancer cells use sugar in the form of glucose. Glucose in the blood comes from a variety of carbohydrate containing foods, not from simple sugars like sucrose, lactose and fructose alone. Blood sugar levels are tightly controlled by the body, not by an individual simply eating dietary sugar or not. When in short supply from diet the body will make its own glucose to ensure continuous supply for all cells. A relationship between sugar, either added or naturally occurring in food is not as direct as eating sugar or not for fueling or starving cancer growth, but in less direct ways sugar and cancer may have a connection.

The strongest evidence connecting sugar to cancer is as a source of excess calories leading to obesity. Obesity is a risk factor for esophageal, pancreatic, colorectal, post-menopausal breast, endometrial, kidney and gallbladder cancers and is also related to increased risk of cancer recurrence and cancer-related death. Several potential mechanisms, including the role of insulin, as blood insulin levels are often higher in obese people, are being explored to explain the connection between obesity and cancer development and progression.

Additional research is ongoing to further elucidate the impact of carbohydrates on cancer risk and outcomes. This includes study of specific foods (including high sugar foods like sugar sweetened beverages), glycemic index and conditions related to glycemic instability such as diabetes, insulin resistance and obesity. Findings from this research may guide future recommendations, but currently there is a lack of evidence to support the notion that added dietary sugars directly “feed” cancer cells or to recommend removing dietary sugars to “starve” a cancer and impact cancer outcomes.

Many patients undergoing cancer treatments experience difficulty eating due to the location of cancer itself or the associated side effects. Additional dietary restriction to limit carbohydrate could potentially result in inadequate caloric and nutrient intake, which can lead to compromised

nutritional status, weight loss and malnutrition decreasing treatment tolerance resulting in treatment delays and reduced survival.

Guidelines from the American Institute for Cancer research describe a healthy approach for including sugar in the diet. For cancer prevention and for anyone who has received a cancer diagnosis and does not require specialized nutrition intervention, a plant based whole food eating pattern that is low in added sugars and highly processed foods is recommended. This dietary pattern will have an overall lower glycemic load and in combination with physical activity promotes healthy weights and overall health. Avoidance of sugar-sweetened beverages is recommended to help individuals manage calorie intake to prevent unintentional weight gain and to promote a nutrient rich diet, but foods high in sugar can be included in small portions as part of this overall healthy eating pattern.

SPEAKING WITH PATIENTS

Bottom line: A cancer diagnosis doesn't result in a need to limit sugar or sugary foods. Health recommendations related to inclusion of dietary sugar intended for the general public also apply to individuals diagnosed with cancer. Counsel cancer patients to not fear sugar or feel guilt when eating foods that contain sugar while encouraging them to focus on eating foods that allow them to keep a healthy body weight.

Considerations When Speaking With Clients

Clients asking about avoiding sugar are likely interested in diet; they are trying to do what they can to help themselves and they don't want to do anything that may cause harm. The role of diet in impacting cancer progression is an emerging area of research, with as yet one diet to be defined. Each person is unique and needs to be assessed independently.

Patient's Nutritional Status

When patients are well nourished and able to eat well, promoting limited added sugars is supported by general health and cancer prevention recommendations. Reducing anxiety around the "must adhere" belief is important and valuable for minimizing food related anxiety and guilt.

Patients who believe it is important to avoid sugar yet are experiencing eating challenges and/or are struggling to maintain their weight may resist recommendations to consume high calorie foods rich in sugar, such as milk shakes, nutritional supplement drinks, and ice cream. They may be more receptive to healthy, calorically dense foods, such as smoothies made with higher fat yogurt or coconut milk, nuts and seeds, extra virgin olive oil, or avocado.

Responses to Common questions or Statements from Patients:

Patient Question: "Do I need to cut sugar out of my diet because I have been diagnosed with cancer?"

RD Response: A cancer diagnosis doesn't mean you need to limit your sugar intake any more than someone without cancer. The general population tends to consume plenty of added sugar, so becoming aware of the amount of sugar in your diet is a healthy step to take. Diets that have a lot of added sugar tend to be low in vitamins and minerals that are essential for your body and also low in compounds that may help protect against or fight cancer. Also, eating high amounts of added sugar can result in getting lots of calories which for some can contribute to weight gain over time. Increased body fat (overweight and obesity) is a risk factor for some types of cancer and some research suggests that it may negatively impact recurrence and prognosis for some cancers. It is important to know, however, that including sugar as part of a healthy diet alone has not been shown to directly cause cancer or its progression.

You as an individual are unique with personalized needs and treatment plans. Many factors will influence your food choices.

For people who are eating well and maintaining weight:

People who eat a typical Western diet that regularly includes highly processed foods and sugar sweetened beverages typically likely consume more sugar than is best for general health. Adjusting your diet to reduce added sugar may be beneficial.

For people who are not eating well and struggling to maintain weight:

Eating during cancer treatment can be difficult for some people, which can result in unintentional weight loss. Many high calorie foods that help maintain weight and prevent further weight loss are also high in sugar. These foods can benefit health by providing additional calories to prevent or minimize weight loss during treatment. See "I've recently been diagnosed with cancer. What type of diet do I need/what should I be eating?"

Patient Question: "Does sugar Feed Cancer?"

RD Response: Sugar does not directly cause cancer nor do sugary foods preferentially "feed" cancer cells. Glucose, a simple sugar, is found in most carbohydrate foods (including grains and cereals, fruits and vegetables, and dairy products) and is the main source of energy for cells in the body, including the brain, immune, blood and muscle cells. Cancer cells also use glucose for fuel but removing sugar from your diet won't "starve" a cancer cell.

Sugar containing foods, whether jelly beans or kidney beans, are generally made of glucose units linked together. During digestion the links are broken so that the individual glucose units can be absorbed into the blood stream and circulated to our cells. Cells cannot tell if glucose has come from a jelly bean or from a healthier food. Although, sugar alone only provides energy, it can provide enjoyment and enhance many healthy foods. Eating small amounts of sugar sweetened food occasionally, such as a piece of birthday cake or a sprinkle of sugar on top of berries doesn't need to cause fear or guilt.

Following a healthy diet such as Canada's Food Guide is recommended during treatment.

Patient Question: "So it doesn't matter if I eat sugar at all then?"

RD Response: Many sugary foods, candy, desserts and sugar sweetened grains (pastry, cookies, and doughnuts) and other sugar sweetened beverages (like regular soft drinks, fruit drinks, coffees) tend to be high in calories and low in vitamins, minerals and other beneficial nutrients. For this reason we suggest limiting sugary foods to occasional treats and in small amounts, for most people. When you eat a lot of these foods or have them often you might get more calories than you need, and as a result gain weight. Being overweight is related to an increased risk of many types of cancer and may impact cancer recurrence.

Patient Question: “I’m confused, on one hand you say it doesn’t matter if I eat sugary foods and now you’ve told me that I might get too many calories when I eat these foods.”

RD Response: Under ideal circumstances we would all eat mostly vegetables, fruits, whole grains, beans and lentils and if desired include small amounts of animal foods. All while keeping our intake of sugary foods to the minimum. Eating can sometimes be very challenging when you have cancer or are undergoing treatments and unintended weight loss is common. The ability to maintain a healthy weight during cancer treatments is important to help get you through cancer treatments as planned, for healing, for supporting your immune system and to help you keep your energy levels up. Because of this, we often encourage people to eat higher calorie foods which can mean more sugar or nourishing foods that also contain sugar, especially when there are limited foods that are tolerated. Puddings, smoothies, milkshakes, and baked goods are often easy for people to eat and provide calories that can help you maintain a healthy weight and other nutrients as well.

Patient Question: “If sugar and sugary foods are not very nutritious would there be any problem with removing all sources of sugar from the diet?”

RD Response: Glucose in our blood doesn’t just come from sugary foods, but also from healthy carbohydrate-containing foods, including vegetables, fruit, whole grains, beans, lentils and dairy. A diet that eliminates all sugar sources would be very restrictive, may be too low in calories and would deprive your body of vitamins, minerals, fibre and other nutrients that are essential for the body. When calorie intake is too low you lose weight and your body breaks down stores including muscles. Maintaining a healthy weight and keeping your muscles strong during cancer treatments helps you get through cancer treatments as planned, supports the immune system and help keep your energy levels up.

RELATED BACKGROUND

How much sugar is consumed by Canadians?

In 2004, the average Canadian consumed approximately 110 grams (approximately 27 teaspoons) of naturally occurring and added sugar combined each day. “Other” foods, including soft drinks, sugar and candy, account for 35% (38.5 grams or about 9.5 tsp) of the sugar consumed (Statistics Canada, 2011).

How much sugar is okay to eat for overall health?

There is no requirement for added or naturally occurring sugar in the diet.

Guidelines that recommended limiting the consumption of added sugar have been established mostly to ensure adequacy of micronutrients and more recently for weight management.

- Added sugar alone and foods high in added sugar tend to be low in micronutrients relative to calories, thus diets that are high in added sugar may be low in vitamins and minerals.
- Consumption of high amounts of sugar can lead to excess calorie intake resulting in weight gain and being overweight or obese. Obesity is a risk factor for chronic diseases including type 2 diabetes, heart disease and cancer.

Guidelines

- *Institute of Medicine (IOM, 2005)*
 - Recommendation: no more than 25% of total calories come from added sugars. (Based on the observation of lower micronutrient intakes when intake from added sugar is high.)
 - In the context of 2000 calorie diet 25% of calories = ~ 31 tsp (125 g) of added sugar (up to 500 calories per day)
- *World Health Organization (WHO, 2003)*
 - Recommendation: no more than 10% of total calories come from added sugars (to improve dietary nutrient density and for weight management).
 - In the context of 2000 calorie diet 10 % of calories = ~ 12.5 tsp (50 g) of added sugar (up to 200 calories per day)
 - New proposed guidelines (2014): no more than 10% of total calories come from added sugars; a reduction to below 5% of total energy intake daily would have “additional benefits” based on growing concerns that sugar, particularly from sugar sweetened beverages, is leading to excess calorie intake and weight gain and is reducing the intake of more nutritious foods. WHO’s guidance on sugar intake is expected to be published in late 2014.
- *American Heart Association (AHA, 2009)*
 - Recommendation: added sugar be limited ½ of one’s discretionary calorie allowance (discretionary calories are the amount of calories remaining after accounting for calories provided by consuming the recommended servings from the food groups) (Johnson et al, 2009). (Guideline is intended to improve weight management, cardiovascular risk and dietary nutrient sufficiency.)
 - In the context of 2000 calorie diet = ~ 8 tsp (32 g) of added sugar (130 calories per day) or 6.5 % of calories.
- *Health Canada (Food Label Review In process 2014)*
 - Health Canada has not previously established recommendations for sugar consumption. A current review of the food label is taking place. This review proposes changes to the food label that address sugar, as excess sugar intake is a source excess calorie intake. With the growing public health concern around obesity and its related risk to chronic diseases including type 2 diabetes, cancer and cardiovascular

- disease proposed food label changes aim to better inform consumers on the sugar content of foods. Changes include: (1) grouping sugar-based ingredients together in the ingredient list and (2) adding the amount of “added sugars” or the % DV for “total sugars” (based on a DV of 100 g) to a food label. For sugar this would mean that 5% DV or less is a little and 15% DV or more is a lot (or that any for containing 15 g or more sugar would be considered high in sugar).
- In the context of a 2000 calorie diet 100 g of added sugar = 25 tsp, 400 calories or 20 % of calories

REFERENCES AND ADDITIONAL RESOURCES

Collins K. AICR In Depth: The Diabetes-Cancer Connection. AICR, 2010.

Fuchs MA et al. Sugar-sweetened beverage intake and cancer recurrence and survival in CALGB 89801 (Alliance). PLoS ONE 2014; 9(6).

Groper SS et al. Carbohydrates. In: Advanced Nutrition and Human Metabolism, Sixth Edition. Belmont: Wadsworth, 2013. p63-107.

Health Canada. Improving Nutrition Information on Food Labels: Better Understanding the Sugar Content of Our Foods. Government of Canada, 2014.

Hu J et al. Glycemic index, glycemic load and cancer risk. Annals of Oncology 2013;24: 245-251.

Institute of Medicine of the National Academies. Dietary Carbohydrates: Sugars and Starches. In: DRI for Energy, Carbohydrate, Fibre, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. Washington DC: National Academies Press, 2005.

Johnson RK et al. Dietary Sugars Intake and Cardiovascular Health: A Scientific Statement From the American Heart Association. Circulation 2009;120:1011-1020.

Langlois K, Garriguet D. Sugar consumption among Canadians of all ages. Statistics Canada, Catalogue no. 82-003-XPE Health Reports 2011;22:3. Accessed September 19, 2012; <http://www.statcan.gc.ca/pub/82-003-x/2011003/article/11540-eng.pdf>

Leser M et al. Oncology Nutrition For Clinical Practice: Oncology Nutrition Dietetic Practice Group. Academy of Nutrition and Dietetics 2013. Tasevska N et al. Sugars in diet and risk of cancer in the NIH-AARP Diet and Health Study. Int J Cancer 2012;130(1):159-169.

Parekh N et al. Obesity, Insulin Resistance, and Cancer Prognosis: Implications for Practice for Providing Care among Cancer Survivors. JADA 2009; 109(8):1346-1353.

Rock CL et al. Nutrition and Physical Activity Guidelines for Cancer Survivors. CA Cancer J Clin 2012;62(4):242-274. <http://onlinelibrary.wiley.com/doi/10.3322/caac.21142/full>



Provincial Health Services Authority

World Cancer Research Fund/American Institute for Cancer Research. Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective. Washington DC: AICR, 2007.

World Cancer Research Fund/American Institute for Cancer Research. CUP Endometrial Cancer 2013 Report: Food, Nutrition, Physical Activity, and the Prevention of Endometrial Cancer. Washington DC: AICR, 2013.

World Health Organization. Diet, nutrition and the prevention of chronic diseases: Report of the joint WHO/FAO expert consultation, WHO Technical Report Series, No. 916 (TRS 916), 2003.

Created by: Andrea Holmes, RD

Edited by: Lindsay Van der Meer, RD

Reviewed by: Erica Kang

Last modified: January 8, 2015