Sugar and Health
Evidence update

Sugar and health is a topic that is surrounded by mixed messages in the New Zealand media. This summary of the current evidence sets out to remove some of the confusion around sugars in food, sugar intake, how sugars are processed in the body, and health effects from sugar consumption.

Consumption of sugar and sweetening of food has steadily increased over time, and so has disease related to diet.\(^1\)\(^2\) The increasing numbers of New Zealanders who are overweight and/or have diabetes\(^3\)\(^4\) has spurred interest in the role of sugars in diet and their effects on health.\(^5\)\(^6\)\(^7\)\(^8\)\(^9\)\(^10\)\(^11\)

Many studies in New Zealand and internationally have provided important information about the links between sugar and disease. How sugar influences health and physical conditions that in turn can lead to chronic disease is increasingly being clarified, and many linkages have been established.\(^12\)\(^13\)\(^14\)

Summary – sugar and health

**EVIDENCE**
There is strong evidence linking sugar consumption with increased body weight as well as tooth decay.

**HEALTH**
Many studies also show an association between a high intake of added sugars and obesity, type-2 diabetes, heart disease and gout – however research to date has not yet fully established the exact mechanisms behind these relationships.

**REDUCING**
No study has shown any negative effects from reducing sugar intake in the diet.

**ADDING**
The current discussion on negative health effects from sugar is mainly concerned with sugars, such as sucrose, that have been added by food manufacturers.

**DRINKS**
Beverages which are high in sugar are nutrient and fibre poor, and can readily lead to overconsumption because they do not lead to a sense of fullness.

**WHO**
The World Health Organization (WHO) recommends a maximum intake of sugars of less than 10% of total energy intake for adults and children, and less than 5% for better health, excluding sugars found in whole fruits, milk and vegetables.

**LABELS**
Current food labelling does not allow consumers to assess how much sugar has been added to food and drinks, making it difficult to follow dietary recommendations and guidelines.
Sugar is a carbohydrate found in natural foods such as fruit, vegetables, honey and milk. Sugar is also used in refined form by manufacturers to sweeten foods and drinks, and for food preservation.

The most common sugars are sucrose, glucose, lactose and fructose. Sucrose is the naturally-occurring combined form of glucose and fructose, also called white sugar or table sugar. Lactose is found in dairy products. These sugars all appear in foods and are classified as added, free and intrinsic sugars:

- **Added sugars** are extracted, concentrated and refined from sources such as sugar cane, fruit, sugar beet, or corn.
- **Free sugars** include added sugars but also include sugars naturally found in honey, syrups and fruit juices – foods that are usually thought of as ‘sweeteners’.
- **Intrinsic sugars** are found naturally in the cell structure of foods such as fresh fruit, grains, vegetables and milk.

Foods with high levels of added sugars can greatly increase the energy (calorie) content of foods without providing any other nutritional benefits, as opposed to whole foods with intrinsic sugars that are accompanied by other nutrients, such as dietary fibre, vitamins, and minerals.

Fruit juice and added sugars in a sweet drink may be more detrimental to your health compared with eating a whole fruit with its intrinsic sugars, for many reasons:

- While the whole fruit also contains minerals, vitamins and fibre with the sugar, the sugary drink mostly consists of water and added sugars.
- The nutritional content will be lower for the drink than for the fruit, while the concentration of sugar will be higher.
- The concentration of sugar can be illustrated by one glass of orange juice, which can contain sugar from as many as five oranges.
- You would be less likely to eat five oranges in one go, as the actual fruit will be more filling due to the fibre content and volume.

If the sugar comes with its inherent fibre (as with whole fruit) then up to 30% of this sugar will not be absorbed. Instead, it will be metabolised by the microbes in the gut, which may improve microbial diversity and help prevent disease. The fibre will also mean a slower rise in blood glucose, which has shown to have positive health effects.

The sugary drink will be easier to consume in large amounts, which increases the overconsumption risk – this is partly because the sugary drink does not offer the same sense of fullness as the equivalent amount of food.

**Added sugars are hard to detect in food and drink**

The current discussion on negative health effects from sugar is mainly concerned with sugars, such as sucrose, that have been added by food manufacturers. Sucrose (derived from refined sugar cane or sugar beet) and high-fructose corn syrup (derived from corn) are used by food manufacturers for sweetening foods and drinks, for food preservation and for enhancing the flavour of processed foods.

In New Zealand, sucrose is commonly used to sweeten fizzy drinks and beverages, whereas high-fructose corn syrup is more commonly used in the US food industry. In foods, added sugars are often found in packaged and processed foods, such as sugary and fizzy drinks, breakfast cereals, muesli bars, biscuits, baked products (cakes, tarts, puddings) and cooking sauces.

Examples of other names for sugar that might be found in packaged foods are dextrose, powdered sugar, corn syrup, honey, maltose, molasses, brown sugar, nectars (e.g. peach nectar), invert sugar, malt syrup, coconut sugars, agave syrup, brown rice syrup and maple syrup.
How much sugar should we be eating?

The World Health Organization recommends that we eat less free sugar* but the guidelines do not apply to intrinsic sugars that are naturally present in fruit, milk and vegetables.\(^{30}\)

For both adults and children, WHO states that the intake of free sugars should be reduced to less than 10% of total energy intake. That is about 50g, or around 12 teaspoons per day (one teaspoon = 4g of sugar). Further reductions to below 5% of the total energy intake (or around 6 teaspoons) could provide additional health benefits.

The infographic on the right illustrates some common everyday foods and their sugar content.\(^{31,32}\)

Food manufacturers in New Zealand do not normally need to declare how much sugar is added and how much sugar is naturally present in a particular food – only the total sugar content must be declared.\(^{33}\) This makes it difficult for the consumer to recognise levels of added sugars in food; sugars which should be limited according to current dietary recommendations.\(^{34}\)

The US Food and Drug Administration have made it compulsory to include added sugars in grams and as a percentage of the daily diet to food labels in the USA from year 2018.\(^{35}\) At present there is no move to do the same in New Zealand.

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* Definition: “free sugars […] include monosaccharides and disaccharides added to foods by the manufacturer, cook or consumer, and sugars naturally present in honey, syrups, fruit juices and fruit juice concentrates” (WHO 2015).
What happens in the body when we eat sugar?

Sugar metabolism is the process by which energy contained in the foods that we eat is made available as fuel for the body. The body’s cells can use glucose directly for energy, and most cells can also use fatty acids for energy. Glucose and fructose are metabolised differently, and when they are consumed in excess they may have different implications for health.

Looking at glucose first – when food is consumed, there is a corresponding rise and subsequent fall in blood glucose level, as glucose is absorbed from the gastrointestinal tract into the blood and then taken up into the cells in the body. Glucose in the blood stimulates the pancreas to release insulin, which then triggers uptake of glucose by cells in the body (e.g. muscle cells) causing blood glucose to return to base levels.

Insulin will turn off fat burning and promote glucose burning as the body’s primary fuel source. Any excess glucose ends up being stored as glycogen in the muscles, and it can also be stored as lipid in the fat tissue.

Fructose is also taken up into the blood from the gut, but in this case, the liver serves as a pre-processing organ that can convert fructose to glucose or fat. The liver can release the glucose and fat into the blood or store it as glycogen or fat depots, which, if sugars are consumed in excess, may lead to fatty liver disease and also increase risk for diabetes and cardiovascular disease.

There are also some noted interaction effects between glucose and fructose, in that glucose enables fructose absorption from the gut, while fructose can accelerate glucose uptake and storage in the liver.

Excessive consumption of added sugars can lead to serious illness

Researchers have found many negative health effects that are related to excessive sugar consumption:

- **Dental health**
  Tooth decay increases with sugar consumption, and high-sugar diets are associated with a higher dental caries risk.

- **Heart disease**
  People who consume high amounts of sugary foods or drinks are more likely to be at risk of heart disease.

- **Weight gain (especially abdominal fat)**
  Increased sugar intake and consumption of added sugars in sugar-sweetened beverages have been linked to body weight gain.

- **Diabetes**
  Evidence shows that people who consume high amounts of sugary foods or drinks are more likely to be at risk of type-2 diabetes.

- **Fat in the blood**

- **Increased blood pressure**

- **Fatty liver disease**

- **Insulin resistance**

- **Gout**

There are a number of scientific studies proposing that fructose may have particularly negative effects on health.

If very high doses of fructose are consumed, fat can accumulate in the liver. This, and other mechanisms, could lead to a range of health conditions.
Strong evidence for weight gain and dental health

The WHO guidelines to reduce free sugars in the diet are based on evidence showing that adults who consume less free sugar have a lower body weight, and that increasing the amount of free sugars in the diet is associated with a comparable weight increase. A link between consumption of added sugars in sugar-sweetened beverages and body weight gain in adults and children has been reported, and these studies have also informed the WHO guidelines. Furthermore, there are a large number of studies showing that beverages in any form are not compensated for by reduced food intake – hence, they add excessive calories to the overall diet and promote weight gain.

Consistent evidence is also found for dental health, where it has been shown that tooth decay increases with sugar consumption. A review of international evidence that contributed to the WHO guidelines on sugar consumption shows that high-sugar diets are associated with a higher dental caries risk. Studies also support that intake of free sugars below the WHO recommendations is associated with a lower risk for dental caries.

Sugar and other non-communicable diseases

Evidence shows that people who consume high amounts of sugary foods or drinks are more likely to have high levels of fat in the blood, insulin resistance, fatty liver, metabolic syndrome, risk of type-2 diabetes and heart disease, and abdominal fat gain than people who do not consume much sugar at all. In some studies, this association continues to hold true even after accounting for the fact that people who consume more sugar may also have higher body weight and energy intake (which are risk factors for the above mentioned diseases).

Because of their high amounts of added sucrose, and the often large quantities consumed on single occasions, sugar-sweetened beverages in particular have been suggested as increasing the risk of chronic disease, independently of obesity.

Some population studies have claimed that our increased consumption of added sugars per se is a factor driving the obesity and diabetes pandemic. However, one limitation with this type of study which is using data on very large groups and not on individuals, is that the outcome (diabetes) is measured on population level, and so is the exposure (added sugars consumption). Because the outcome and the exposure data are not linked to the same individuals, these studies can only show general associations, and they are identifying only one component of what is likely to be a multi-factorial problem.

A comprehensive review of different dietary intervention trials compared the effects of high and low consumption of added sugars on risk factors for cardiovascular disease, where the only difference was the amount of sugars and non-sugar carbohydrates that the participants had consumed. The review found that sugars seem to contribute to risk of heart disease, independent of the effect that sugar has on body weight.

Studies in rodents have provided some insights into the underlying mechanisms involved, including reports that high levels of sugar intake are linked with arrhythmias, heart muscle cell death and disturbed metabolism in heart cells. These conditions appeared even in the absence of changes in body weight or diabetic blood glucose levels, suggesting that excess sugar consumption may be dangerous for the heart even when someone is slim and seemingly healthy. These ‘cause-and-effect’ data are preliminary and require validation in human tissues.
Is fructose more threatening to health than glucose?

There are a number of studies proposing that, compared to glucose, fructose may have particularly adverse effects, leading to fat accumulation, atherosclerosis, raised blood pressure, appetite disruption, and insulin sensitivity.

The adverse health effects of fructose would not simply be due to the excess energy or total sugar intake – it is suggested that fructose could have an independent effect on health because of how the fructose is affecting and disrupting the metabolic process, but more research is required to establish the exact mechanisms.

If very high doses of fructose are consumed, fat will accumulate in the liver, and glucose will not be metabolised as efficiently anymore. This could lead to excessive insulin release or what is called hyperinsulinemia, increased levels of fats in the blood that can lead to heart disease, and increased uric acid levels or hyperuricaemia that in turn can lead to gout.

The latter condition may have particular relevance to New Zealand, as Pacific Island populations (particularly those of Polynesian descent) have showed a high prevalence of hyperuricaemia and gout. This could be due to an inherently higher uric acid level among these populations, with a demonstrated genetic predisposition. Fructose has been shown to increase uric acid levels, so the suggested chain of events is that the fructose causes heightened uric acid levels – of already (inherently) high levels – which can then lead to gout.

There is an emerging body of evidence showing that very high fructose doses (more than 100 g/day, which you would have to eat 200 g of sucrose to achieve, or four times the WHO recommended level) may promote weight gain and fatty liver disease, which are known risk factors for diabetes.

The few studies that have investigated low and moderate levels of fructose consumption in humans have not been able to identify consistent adverse effects from fructose, compared to other sugars. So – whether fructose has a particularly significant negative impact on health compared to glucose, and whether it can cause direct negative health effects independently, remains an active area of research.

Where are the gaps in the research on sugar and health?

More research is needed to understand the exact mechanisms linking sugars to poor health outcomes, compared with other macronutrients – fats, proteins and other carbohydrates – in our diet, and there is especially a need for intervention studies that can provide high-grade evidence.

WHO has outlined some gaps where more research is needed in order to revise the WHO sugar consumption recommendations in 2020:

- How the intake of free sugars affects metabolism.
- Longer-term studies showing how changes in free sugars intake affect health.
- Thresholds above which the consumption of free sugars increases weight gain.
- The effectiveness of behavioural changes in reducing the intake of free sugars.

Our experts

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** To consume 100 g fructose, you would need to consume about 200 g of sucrose (which is made up by 50% fructose and 50% glucose). To achieve a total of 100 g fructose you would need to consume the equivalent of about 2 L of a sugary soft drink, or 3 bottles of a sports energy drink, or 12 pieces of whole fruit.
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