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Sugary beverages represent a threat to global health

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Sugary beverages represent a major global threat to the health of all populations. The shifts in distribution, marketing, and sales have made them the plague of the globe in terms of obesity, diabetes, and a host of other chronic health problems. The fructose-laden beverages have unique properties that lead to lack of dietary compensation and direct adverse effects on our health. Global efforts to limit marketing and sales are necessary to protect the health of the planet.

Sugary beverages, a new addition to our diet

The past several decades have seen a sharp increase across the globe in the consumption of caloric beverages. The adverse health effects of consuming soft drinks (carbonated and noncarbonated), energy drinks, vitamin waters, fruit juice, and fruit drinks are clear. Sweeteners, in the form of fruit, berries, and honey, have been a seasonal component of the human diet for tens of thousands of years. It is only in the recent few thousand years that caloric beverages such as alcohol and cow's milk have emerged as an alternative to water. However, in the past 30 years there has been a rapid shift away from water and other non-caloric or dairy beverages and alcohol, and for many of us a global intake of several hundred extra calories a day from sugary beverages has now become the new norm. What this means for human health and well-being is the focus of this paper (Box 1).

Sugary beverages do not replace food intake

Only since 1996 have we begun to understand that humans process beverages differently than food. Even when consuming a protein-, fat-, or carbohydrate-rich caloric beverage, humans do not compensate for even a small percentage of the added calories by reducing food intake [1]. We do not fully understand the mechanisms that explain this. What is clear is that we need beverages to survive. We die if we do not drink liquids for three to seven days [2], whereas we can survive for months without eating food. From an evolutionary perspective, food was seasonal, and we needed to eat it when it was available, whereas we constantly needed water (or breast milk for the infant).

When we shift from water to caloric beverages we add calories to our diet. Furthermore, the global increase in vast marketing and sales of beverages with caloric sweeteners (CS; see Glossary) has produced a major mismatch between our biology and the power of the beverage industry to create a market for CS beverages and distribute them in all corners of the planet.

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Keywords: sugar-sweetened beverages; fructose; beverage consumption; world; fruit juice.

The global increase in sugary beverages is accelerating

Until about 2005, the consumption of CS beverages increased in the US and high-income European countries. However, there appears to be a concerted campaign in some areas of the world to replace CS beverages with beverages containing non-caloric sweeteners (NCS), which are often but not always sugar-free beverages. In the US this has led to a decline in the average kilocalories (kcal) per ounce of soft drinks consumed [3]. By contrast, Brazil, China, and almost all other low- and middle-income countries are experiencing a very rapid increase in the marketing and sales of soft drinks and other CS beverages [3]. In addition, because the large distribution companies also sell juices, vitamin waters, energy drinks, and other caloric drinks, most of which contain high amounts of sugar, consumption of these beverages is increasing. In the US and Europe we have also documented very large increases in high-fat CS milks (e.g., chocolate milk), available through school cafeterias.

As we and others have shown in many studies, CS beverages are heavily consumed by children. In the US and several other countries, consumption of CS beverages begins in the first year of life, and by age two they represent significant contributions to the diet [4]. Adolescents and young adults (approximate age-range 12 to 29) are the two largest groups of CS beverage consumers.

The cardiometabolic effects from excessive consumption are profound, at all ages

The major mechanism linking CS beverages to adverse health outcomes is the lack of satiety from the consumption of liquid calories, and the incomplete compensatory reduction in subsequent energy intake, mechanisms that we do not understand yet [1]. There is a large body of epidemiological and small clinical studies literature that points to

Glossary

Caloric sweetener (CS): sucrose, corn syrup, honey, and all other sugars, all of which contain fructose.

Fruit juice: mainly consumed as a combination of flavorings, water, and fruit juice concentrate.

Glycemic load: a number that estimates how much a particular food will, after ingestion, raise the blood glucose level of a person. One unit of glycemic load approximates the effect of consuming 1 g of glucose (carbohydrate), and accounts for how much each g of carbohydrate in the food raises blood glucose levels. GL is based on the glycemic index (GI) and is defined as the grams of available carbohydrate in the food $\times$ the GI of the food/100. It has been shown that diets with high GI may significantly contribute to the development of type 2 diabetes compared to diets with lowest GI. GL is a highly recommended tool for managing blood sugar for people with diabetes.

Non-caloric sweetener (NCS): a sugar substitute that duplicates the effect of sugar in taste and that contains less food energy (Kcal). Some sugar substitutes are natural (stevia) and some are synthetic (aspartame). Synthetic NCSs are also termed artificial sweeteners.

Trends in Endocrinology and Metabolism December 2012, Vol. 23, No. 12

Box 1. What do beverages with caloric sweeteners do to us?

- Provide energy in liquid form which is not compensated by reducing food intake.
- Provide high glycemic load, leading to postprandial hyperglycemia and primary hyperinsulinemia.
- Alter long-term taste preferences toward increased sugary food intake.
- Provide refined sugars that directly affect dental health.
- Often displace lower glycemic load and more satiating and nutritious foods.
- Provide excessive fructose with direct impact upon uric acid production, visceral fat, and the synthesis of fat in the liver.

the increased risk of weight gain, enlarged waist circumference, diabetes, fatty liver disease, and many other cardiometabolic outcomes. The effects on type 2 diabetes and heart disease seem to be particularly significant [5], although numerous other outcomes, including kidney stones and fatty liver disease, also appear to be important.

This research holds for both children and adults, and appears to explain important dimensions of weight gain and obesity among children in countries with high levels of CS beverage consumption. Furthermore, whether it is heavy consumption of fruit juice in one country or of soda in another, the effects are similar [6,7].

Emerging science points to fructose as the culprit

Recent evidence suggests that the problem is the fructose content of CS beverages [8]. Fructose is found in approximately equal proportions in sucrose, corn syrup, honey, and other sugars. Fructose may have particularly adverse effects on blood pressure via increased uric acid, and may increase deposition of visceral and ectopic fat, lipid metabolism, and insulin sensitivity (through synthesis of fat in the liver), compared to glucose. Fructose intake may also lead to weight gain by decreasing the production of insulin and leptin in peripheral tissues, thereby initiating the hunger cascade in the central nervous system. The field of exploration of the fructose pathway is still very young [9] relative to the research on CS beverages. Much of this fructose research to date has been with adults, but it is clear that the effects should be generalizable to all age groups.

Humans have always consumed fructose; however, what is significant is the shift from fruit and honey, as the major sources, to fruit juice and sugar-sweetened beverages. Research implicates each of these beverages in adverse outcomes [5,10,11].

Noncaloric sweeteners: current knowledge does not point to adverse effects

NCSs are either commercially prepared (e.g., aspartame), natural (e.g., stevia), or contain a very low number of calories (e.g., sugar alcohols). The literature on the potential mechanisms by which NCSs can affect health has been reviewed elsewhere [12]. There are no clear toxicological adverse effects associated with NCS. However, the question is – does NCS beverage consumption increase sweetness preferences and consequently affect food selection, causing intake of sweeter foods that often are high in refined carbohydrates? Only one random controlled trial has compared water, NCS beverages, and CS beverages [13]. This trial found positive weight reduction with consumption of either water or NCS beverages, instead of CS beverages, but was not powered to test the effects of NCS beverages versus water.

The choices: ignore or regulate

A strong set of regulations is needed to limit significantly the intake of CS beverages, including fruit juices. There is increasing unanimity across the globe that sugary beverages are a key target, and a punitive tax of 20 percent or more has been suggested as the ideal first step. Health ministers in the Gulf States have proposed a 50% tax in 2012 [14]. Clearly, prohibition is not seen as an answer, except in schools and other public facilities. However, reducing portion sizes, as New York City is doing, is a small step forward.

About 20 countries have banned, in schools, provision of CS beverages (including fruit juices, in a few countries). To date many regions (e.g., the Gulf States, Mexico, Denmark, and some states and counties in the US) are either seriously considering or have attempted to tax sugary beverages. None have taxed fruit juices, which are mainly a combination of flavorings, water, and fruit juice concentrate, but some are seriously considering them. Many islands in the Western Pacific have taken strong action to ban or limit their importation.

As do tobacco companies, beverage companies fight hard to prevent the implementation of any regulations or taxation, and employ corporate responsibility campaigns, political lobbying, advertising campaigns, and other weapons to thwart or delay these public responses [15]. Also as with tobacco, public opinion is slowly shifting against these beverage companies, and more controls and regulations are emerging.

Action is needed. Sugary beverages, including fruit juices, represent a large component of the increased caloric intake and a major cause of not only obesity and diabetes but many other chronic diseases. As a crucial first step toward preventing further increases in the global epidemic of non-communicable diseases, reducing significantly the consumption of sugars from beverages is essential.

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1043-2760/$ – see front matter
http://dx.doi.org/10.1016/j.tem.2012.07.003 Trends in Endocrinology and Metabolism, December 2012, Vol. 23, No. 12