

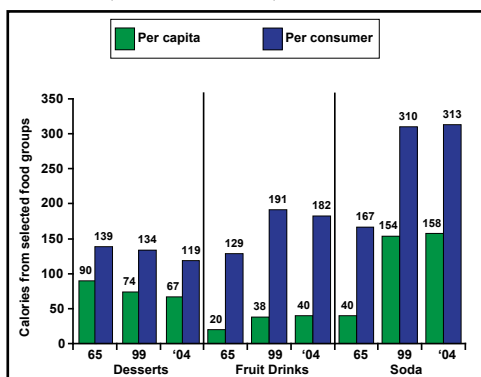
Cardiometabolic Corner: Updates from the International Chair on Cardiometabolic Risk

Written by Maria Vinall

Our preference for sweetness is not new, but over the past 20 years there has been a remarkable increase in the consumption of refined sugars around the globe. Of particular interest to anyone interested in cardiometabolic risk is the fact that the growing use of high-fructose corn syrup between 1970 and 1990 has paralleled the rising prevalence of obesity in the period between 1970 and 2000 [Bray GA. *CMRejournal*. <http://www.cardiometabolic-risk.org/cmrejournal/>].

The main source of this increase in refined sugar consumption has been from sugar-sweetened beverages, including soft drinks, fruit drinks, energy drinks, and vitamin and other functional beverage waters (Figure 1). “For reasons that we do not fully understand,” said Barry Popkin, PhD, University of North Carolina, Chapel Hill, NC, “humans do not reduce food intake when we consume calorie-containing liquids.” Thus, this lack of compensation for caloric intake creates a shift in our net energy balance that plays a major role in the global increase in abdominal obesity and metabolic conditions [Wolf A et al. *Obes Rev* 2008]. This effect is worsened when combined with an accelerated shift toward inactivity and poor diet.

Figure 1. Relative Contribution of Sugar from Desserts, Fruit Drinks, and Soda: 1965 to 2004.



Source: Duffy KJ & Popkin BM. *Am J Clin Nutr* 2008;88(Suppl):1722S.

As with tobacco, sugar-sweetened beverages are associated with no health benefits and high health costs. A few countries, most notably Mexico, are attempting to shift beverage consumption back to healthier options through taxation. Other countries have banned vending machines from schools, and from media to which children and teens are exposed. There is evidence that such programs work, especially when combined with the provision of inexpensive healthy alternatives, such as potable water.

The deleterious effects of overconsumption of sugar-sweetened beverages have been well documented. In a study that examined the metabolic effects of fructose in healthy men (n=8) and women (n=8), Couchepin and colleagues found that short-term (6 days) fructose overfeeding produces significant (p<0.05) increases in fasting triglyceride levels (71% increase), endogenous glucose production (12%), alanine aminotransferase (38%), and fasting insulin concentrations (14%) in men. The effects were less pronounced in women, although significant (p<0.05) changes were observed in fasting glucose (4%) and triglycerides (16%). The investigators suggested either that the difference in response was related to the effect of estrogen on fructose metabolism or that women may remove triglyceride-rich particles from circulation more efficiently than men [Couchepin C et al. *Diab Care* 2008].

When Raben and colleagues investigated the role of artificial sweeteners in body weight regulation, they found that overweight subjects (n=21) who consumed fairly high levels of sucrose, mostly as beverages, had increased total energy (by 1.6 MJ/d), body weight (1.6 kg), fat mass (1.3 kg), and blood pressure (3.8 mm Hg and 4.1 mm Hg, systolic and diastolic, respectively) after 10 weeks. These effects were not observed in a similar group of subjects who consumed artificial sweeteners (n=20) [Raben. *Am J Clin Nutr* 2002]. A further analysis of data from this study showed increases in several markers of inflammation in the sucrose group (Table 1) [Sorensen LB et al. *Am J Clin Nutr* 2005].



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Table 1. Changes in Concentrations of Inflammatory Markers Associated with Sugar-Sweetened Beverages.

Marker	Sucrose	Aspartame	p Value
Haptoglobin	+13%	-16%	p=0.006
Transferrin	+5%	-2%	p=0.01
C-reactive Protein	+6%	26%	p=0.10

Source: Sorensen LB et al. *Am J Clin Nutr* 2005;82:421-427.

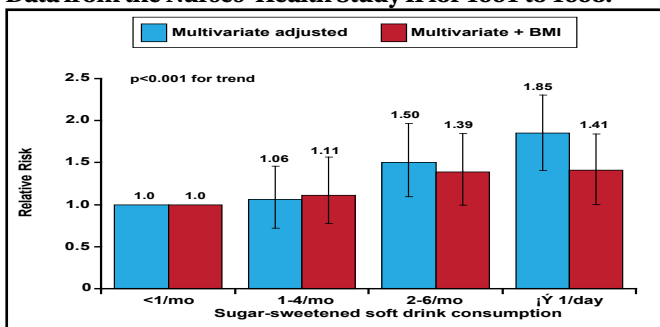
Of particular relevance to the metabolic syndrome, fructose appears to have a much greater effect on increases in visceral fat than other sugars [Stanhope KL et al. *J Clin Invest* 2009]. Other studies have shown a potential connection between the consumption of soft drinks and gout [Choi HK & Curhan G. *BMJ* 2008], as well as diabetes and the metabolic syndrome [Johnson RJ et al. *Endocr Rev* 2009].

After reviewing the literature, Dr. Bray said he has concluded that, “In the amounts now ingested, fructose is hazardous to the health of some people.”

Soft drinks are an important source of glycemic load in the diet of United States residents, and epidemiological studies have reported that a higher glycemic load, especially combined with low intake of cereal fiber, significantly elevates long-term risk of type 2 diabetes and coronary heart disease (CHD) [Hu FB & Willett WC. *JAMA* 2002].

Eight-year data from the Nurses’ Health Study II showed that increased consumption of sugar-sweetened beverages was associated with a significant (p<0.001) trend for an increased risk for diabetes, regardless of whether the data were controlled for body mass index (BMI; Figure 2) [Schulze MB et al. *JAMA* 2004]. These results suggest that the detrimental effects of soft drinks on type 2 diabetes are not completely mediated through energy balance or body weight.

Figure 2. Sugar-Sweetened Soft Drinks and Type 2 Diabetes; Data from the Nurses’ Health Study II for 1991 to 1998.



Source: Adapted from Schulze MB. *JAMA* 2004;292:927.

Data from the Black Women’s Health study also showed a significant relationship between sugar-sweetened soft drink consumption and the risk for diabetes among 43,960 African-American women who were followed from 1995 to 2001 [Palmer JR et al. *Arch Int Med* 2008]. There were 2713 incident cases of type 2 diabetes during the follow-up

period. The RR (adjusted for confounding variables) for ≥2 soft drinks/day was 1.24 (95% CI, 1.06 to 1.45) and 1.31 (95% CI, 1.13 to 1.52) for fruit drinks. The association of diabetes with soft drinks was primarily mediated by BMI; the fruit drink association was independent of body weight.

Using data from the Framingham Heart Study, Dhingra and colleagues found that in middle-aged adults, consumption of ≥1 soft drink/day is associated with increased odds of developing metabolic syndrome (OR, 1.44; 95% CI, 1.20 to 1.74), obesity (OR, 1.31; 95% CI, 1.02 to 1.68), increased waist circumference (OR, 1.30; 95% CI, 1.09 to 1.56), impaired fasting glucose (OR, 1.25; 95% CI, 1.05 to 1.48), higher blood pressure (OR, 1.18; 95% CI, 0.96 to 1.44), hypertriglyceridemia (OR, 1.25; 95% CI, 1.04 to 1.51), and low high-density lipoprotein cholesterol (OR, 1.32; 95% CI, 1.06 to 1.64) [Dhingra R et al. *Circulation* 2007].

In a recent study, women from the Nurses’ Health Study (n=88,520) were followed for 24 years (1980 to 2004), during which time there were 3105 incident cases of CHD. Regular soft drink consumption was shown to be associated with a significantly (p for trend <0.001) increased risk of CHD, even after adjusting for unhealthy lifestyle or dietary factors (Table 2). Additional adjustments for BMI, energy intake, and incident diabetes attenuated the associations, but they remained significant. Artificially sweetened beverages were not associated with CHD [Fung TT *Am J Clin Nutr* 2009].

Table 2. Relative Risk for CHD Based on Sugar-Sweetened Beverage Consumption.

Cumulative Average of SSB Consumption	RR (95% CI) for CHD
<1 serving/month	1.0
1 to 4 servings/month	0.96 (0.87, 1.06)
2 to 6 servings/week	1.04 (0.95, 1.14)
1 serving/day	1.23 (1.06, 1.43)
≥2 servings per day	1.35 (1.07, 1.69)

Source: Fung TT *Am J Clin Nutr* 2009

“The detrimental effects of sugar-sweetened beverages stem from both increased caloric intake and glycemic load,” said Dr. Hu.

Commenting on the presentations, Jean-Pierre Després, PhD, Scientific Director, International Chair on Cardiometabolic Risk, said, “A robust action plan should be put into place to battle the epidemic of obesity underlying the huge prevalence of type 2 diabetes that is limiting our ability to successfully combat cardiovascular disease. Although the question is complex, it would appear that a focus on limiting the consumption of sugar-sweetened beverages may represent a simple initial step to reduce caloric intake and help to prevent or manage obesity and its related complications.”