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SUGAR-SWEETENED BEVERAGES AS A MAJOR MODIFIABLE RISK FACTOR FOR TYPE 2 DIABETES

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Key Points

- An increased consumption of sugar-sweetened beverages (SSBs) is associated with a higher risk of developing obesity in children and adults.
- An elevated consumption of SSBs increases the risk of developing type 2 diabetes beyond its deleterious impact on body weight.
- A higher intake of SSBs has also been associated with a greater risk of developing cardiovascular disease.

Sugar-sweetened beverages (SSBs) include the full spectrum of soft drinks (soda), fruit drinks, and energy and vitamin water drinks. Consumption of SSBs has been rising rapidly in the US. Between the late 1970's and 2001 the percentage of total calories consumed from SSBs increased from 3.9% to 9.2% [1]. SSBs have become the primary source of added sugars in the US diet and a major source of excess calories. There is convincing epidemiologic evidence that higher consumption of SSB intake is associated with significantly elevated risk of weight gain and obesity in children and adults [2-3]. SSBs lead to positive energy balance and weight gain due to decreased satiety and an incomplete compensatory reduction in energy intake at subsequent meals following intake of liquid calories. On average, one 12-oz serving of SSB contains about 140-150 calories. If these calories are added to the typical US diet without reducing calories from other sources, one SSB per day could lead to a substantial weight gain (up to 7 kg or 15 lbs) over the course of one year [3].

There is mounting evidence that higher consumption of SSBs increases the risk of type 2 diabetes mellitus (T2DM), even after taking into account their effects on body weight. We recently conducted a meta-analysis of prospective cohort studies of SSB consumption and risk of T2DM [4], including 310,819 participants and 15,043 cases of T2DM. In this meta-analysis, we found that individuals in the highest quantile of SSB intake (most often 1-2 servings/day) had a 26% greater risk of developing T2DM than those in the lowest quantile (none or <1 serving/month) (relative risk [RR]= 1.26, 95% CI: 1.12-1.41) (Figure 1).

The largest cohort study published so far is the Nurses' Health Study II (NHS II). In the NHS II, a cohort of over 50,000 women, those who consumed ≥1 SSB/day had an 83% greater risk of developing T2DM over the course of 8 years compared to those who consumed <1 SSB/month after adjusting for potential confounders (RR=1.85, 95% CI: 1.42-2.36, p<0.001 for trend) [5]. After further adjustment for body mass index (BMI), the RR comparing extreme categories of intake decreased to 1.41 (95% CI: 1.09-1.83, p<0.001 for trend), but was still statistically significant, suggesting that the excess risk was not completely explained by BMI. Similar results were reported in the Black Women's Health Study. Among over 40,000 women followed for 10 years, those who consumed ≥2 SSBs/day had a 24% greater risk of developing T2DM compared to those who consumed <1 SSB/month (RR=1.24, 95% CI: 1.06-1.45, p=0.002 for trend) [6]. In both cohort studies, increasing consumption of SSBs was associated with significantly greater weight gain, even after adjustment for other dietary and lifestyle factors.

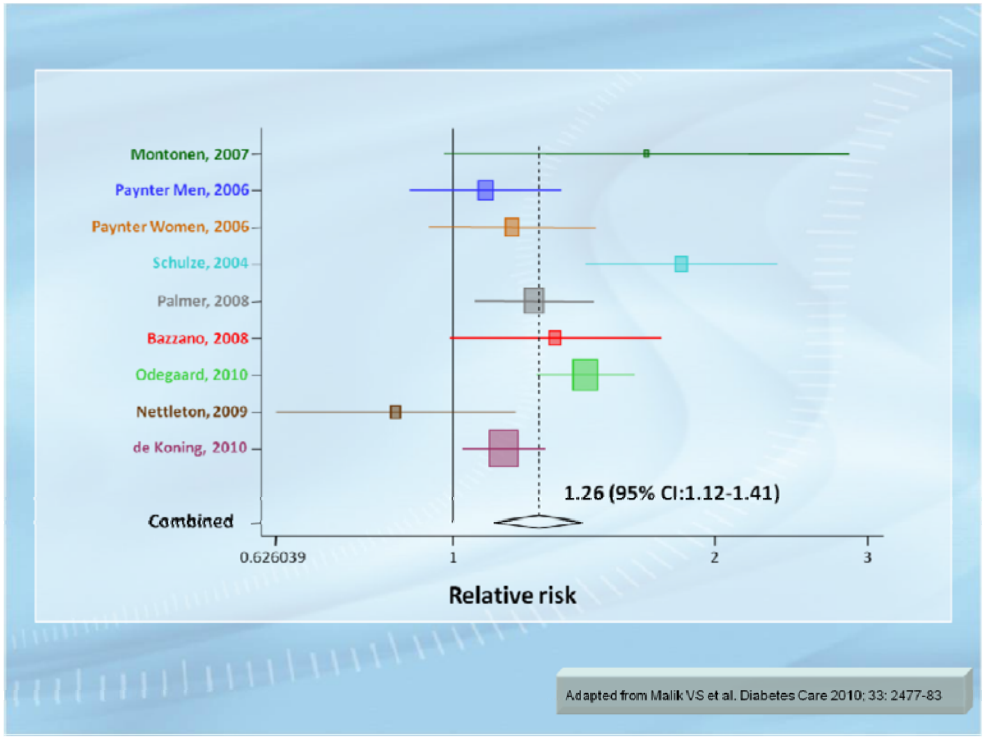

Figure 1: Forrest plot of studies evaluating sugar-sweetened beverage consumption and risk of type 2 diabetes mellitus, comparing extreme categories of intake (random – effects estimate).

In the NHS, we found that a higher level of SSB intake was associated with increased risk of developing coronary heart disease (CHD) [7]. In over 88,000 women followed for 24 years, those who consumed ≥2 SSBs/day had a 35% greater risk of CHD compared to infrequent consumers, after adjusting for other unhealthy lifestyle factors (RR=1.35, 95% CI: 1.1-1.7, p<0.01 for trend). Additional adjustment for potential mediating factors including BMI, total energy intake and incident T2DM attenuated the associations but they remained statistically significant, suggesting that the effect of SSBs is not entirely mediated by these factors.

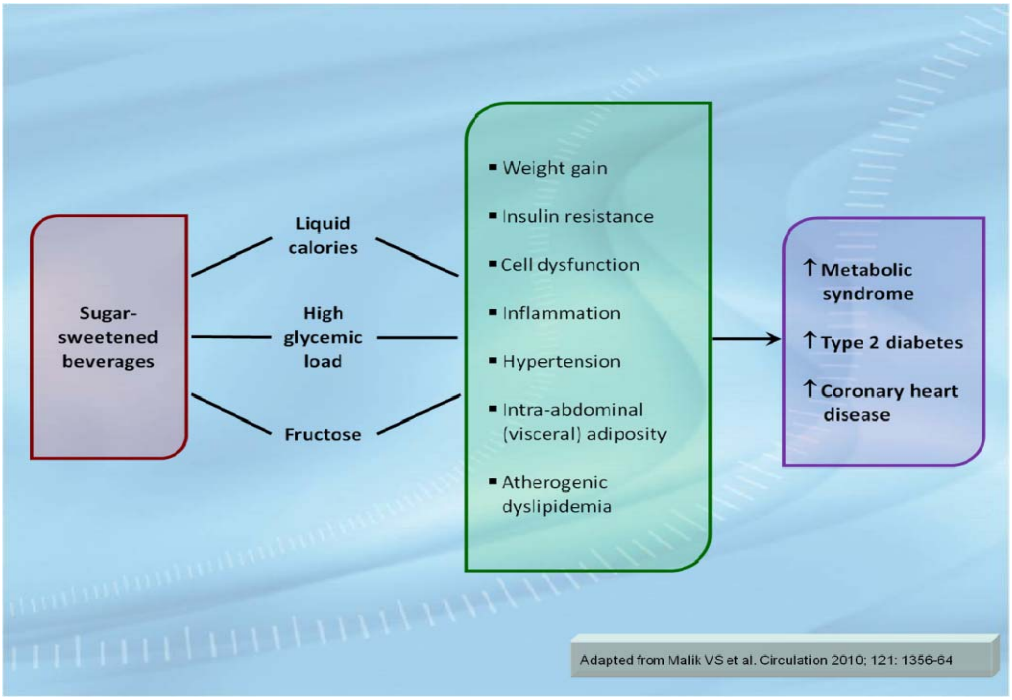

Figure 2: Potential biological mechanisms underlying the effect of sugar-sweetened beverages on weight gain and cardiometabolic disease risk.

The adverse effects of SSBs on cardiometabolic risk may be explained by several mechanisms. In addition to weight gain, the large quantities of rapidly absorbable carbohydrates such as sucrose or high-fructose corn syrups that are used to flavour these beverages, may also contribute to the risk of T2DM and CHD (Figure 2). SSBs contribute to high dietary glycemic load, which lead to rapid increases in blood glucose and insulin levels following consumption. A high glycemic load diet has also been implicated in the increased risk of T2DM and cardiovascular disease [1].

The fructose content of SSBs may exert additional adverse metabolic effects. Fructose is preferentially metabolized to lipid in the liver, leading to increased hepatic de novo lipogenesis, dyslipidemia and insulin resistance [8]. Fructose consumption has also been shown to promote accumulation of intra-abdominal (visceral) adiposity. In a recent study comparing the 10-week effects of consuming glucose- or fructose-sweetened beverages providing 25% of energy requirements, both groups showed similar weight gain, but only the fructose group showed a significant increase in intra-abdominal adiposity [9].

In summary, there is strong epidemiologic and clinical evidence linking SSBs and increased risk of obesity and T2DM. Thus, limiting intake of SSBs is critical for prevention of these conditions. Recently, the American Heart Association released a scientific statement recommending reductions in added sugar intake to no more than 100-150 kcal/day for most American women and men respectively, as a means of reducing cardiovascular disease risk [10]. Currently, a number of public health campaigns to limit intake of SSBs are underway and strategies such as taxation are being considered as a means of reducing intake of SSBs in the general population. Although many factors contribute to a growing pandemic of obesity and T2DM, ample evidence exists to indicate that regular consumption of SSBs is an important modifiable risk factor for these conditions. Thus, reducing consumption of SSBs in place of healthy alternatives such as water should be widely recommended to reduce risk of obesity and T2DM.

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