Review Article

Added Sugars - The New Tobacco - The Contemporary Perspectives

Navneet Wadhwa, MD (Pharmacology), *Mumbai, India*

Introduction

Sugar-sweetened drinks have been associated with several health problems. About 75% of all foods and beverages contain added sugar in a large array of forms. Consumption of soft drinks has increased fivefold since 1950. Consumption of calorie-sweetened beverages has continued to increase and plays a role in the epidemic of obesity, the metabolic syndrome, and fatty liver disease. Reducing intake of soft drinks is associated with less weight gain. The intake of added sugars, such as from table sugar (sucrose) and high-fructose corn syrup has increased dramatically in the last hundred years and correlates closely with the rise in obesity, metabolic syndrome, and diabetes.

Obesity has reached epidemic proportions globally and the prevention of adult obesity will require prevention and management of childhood obesity. Sedentary lifestyles, including increasing fast food preferences may be responsible for increasing occurrence of pediatric and adolescent obesity in this population. It is well established that Sugar-sweetened drinks and the fructose they provide are associated with several health problems.

This last decade has brought a sea change in understanding the health impact of caloric beverages in general and at the same time of the health impact of fructose in any form be it food or beverage on the health of children, adolescents as well as adults. The beverage effect is particularly important because of the lack of caloric compensation when a beverage is consumed.

From: Medical Services, Alkem Laboratories Ltd., India (N.W.)

Corresponding Author: Dr. Navneet Wadhwa, MD (Pharmacology), Deputy General Manager, Medical Services, Alkem Laboratories Ltd., Mumbai, India

Email: navneet.wadhwa@alkem.com

Epidemiologic Trends, Problem Statement and Risk Associations

Soft drinks and other sugar-sweetened beverages are the primary source of added sugars in Americans' diets. Excessive consumption of sugars has been linked with several metabolic abnormalities and adverse health conditions, as well as shortfalls of essential nutrients Although trial data are limited, evidence from observational studies indicates that a higher intake of soft drinks is associated with greater energy intake, higher body weight, and lower intake of essential nutrients. Most American women should eat or drink no more than 100 calories per day from added sugars, and most American men should eat or drink no more than 150 calories per day from added sugars

The prevalence of obesity and related chronic diseases is rising at unprecedented rates across the globe. Identification of modifiable risk factors is therefore essential to abating this escalating pandemic. Temporal patterns in SSB intake across recent decades have shown a close parallel between the obesity epidemic and rising levels of SSB consumption. Findings from epidemiological studies clearly indicate that regular consumption of SSBs can lead to weight gain and substantially increase risk of developing chronic diseases including Metabolic Syndrome, T2DM and CHD.

In general, longer studies with greater numbers of participants that did not adjust for potential mediators of effect such as total energy intake and adiposity, report stronger and more consistent associations. Evidence for adverse effects on other metabolic conditions including hypertension, inflammation, atherogenic dyslipidemia, hyperurecemia, gout, gallstone, and kidney disease is also starting to emerge. SSBs are the greatest contributor to added sugar intake in the US and are thought to induce weight gain in part by incomplete compensation for liquid calories at subsequent meals. SSBs may also increase

T2DM risk independently, as a potential contributor to a high dietary GL leading to inflammation, insulin resistance, and impaired beta-cell function. Additional metabolic effects from the fructose fraction of these beverages may also promote accumulation of visceral adiposity, and atherogenic dyslipidemia due to elevated hepatic *de novo,* and hypertension due to hyperuricemia. Such excess risk could have serious repercussions for developing countries, which must manage dual burdens of chronic and infectious disease as well as for certain populations such as Hispanics or South Asians, which are particularly prone to development of visceral adiposity and T2DM. Given the increasingly large quantities of SSBs consumed by children and adolescents, limiting intake is critical to obesity prevention in this population. Childhood obesity is known to increase risk of obesity in adulthood and can lead to serious downstream health effects.

The World Health Organization (WHO) recommends that added sugar constitutes <10% of calorie intake. The Institute of Medicine (IOM) in the USA currently recommends that adults limit their intake of added sugar to <25% of calorie intake. In 2003, the World Health Organization, responding to increasing concerns over the rising tide of obesity, stated that "added sugars"—specifically non-milk extrinsic sugar—should contribute no more than 10% of total energy intake. In 2009, the American Heart Association published a scientific statement in Circulation entitled "Dietary sugar intake and cardiovascular health." The article noted that excessive consumption of sugar had been linked to several metabolic abnormalities and adverse health conditions combined with shortfalls in essential nutrients. Acknowledging that the average US citizen was consuming a staggering 22 teaspoons of added sugar a day, greatly exceeding discretionary calorie allowances, the paper stressed an upper limit of 100 kilocalories a day from added sugar for a woman (six teaspoons) and 150 kcal a day for a man (nine teaspoons).

Fructose-induced Cardiometabolic risk

Fructose is a major component of added sugars and is distinct from other sugars in its ability to cause intracellular ATP depletion, nucleotide turnover, and the generation of uric acid. Fructose metabolism is unique that accounts for why fructose intake increases the risk for metabolic syndrome. Fructose-induced uric acid generation causes mitochondrial oxidative stress that stimulates fat accumulation independent of excessive caloric intake. The discovery that fructose mediated generation of uric acid may have a causal role in diabetes and obesity provides new insights into pathogenesis and therapies for this important disease

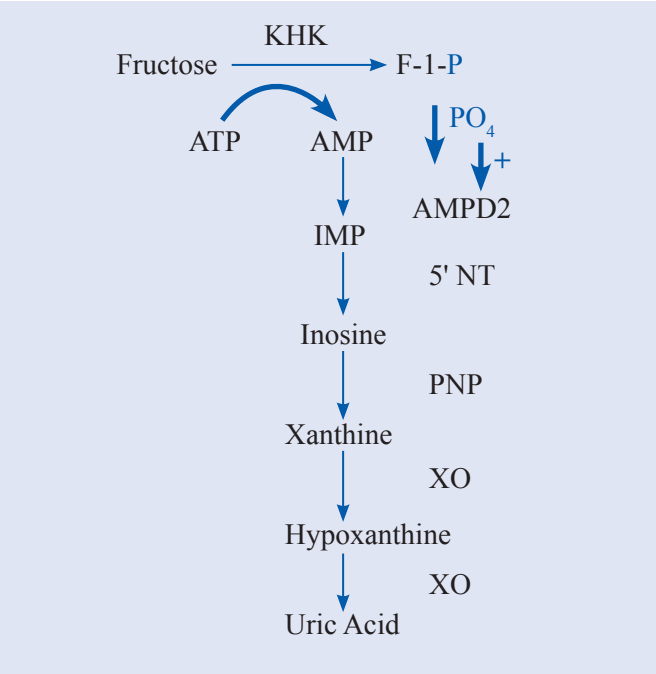

Figure 1. Fructose-induced nucleotide turnover

The most important issue is to understand the impact of fructose on cardiometabolic health, be it from food or beverages, when consumed in any meaningful quantity. Data suggest that added sugars induce atherosclerosis, hypertension, peripheral vascular disease, coronary artery disease, cardiomyopathy, heart failure, and cardiac arrhythmias and that these effects of added sugars are mediated through Reactive Oxygen Species (ROS).

Recent evidence based perspectives

In a recent study it has been demonstrated that low added sugars consumption is associated with increasing HDL cholesterol levels throughout adolescence. This was based on the data analysed from the data from the National Heart Lung and Blood Institute's Growth and Health Study, which has been a 10-year cohort study of non-Hispanic Caucasian and African-American girls (N=2379) aged 9 and 10 years at baseline recruited from 3 sites in 1987-1988. Biennial plasma lipid measurement and annual assessment of diet using a 3-day food record was done. Added sugars consumption was dichotomized

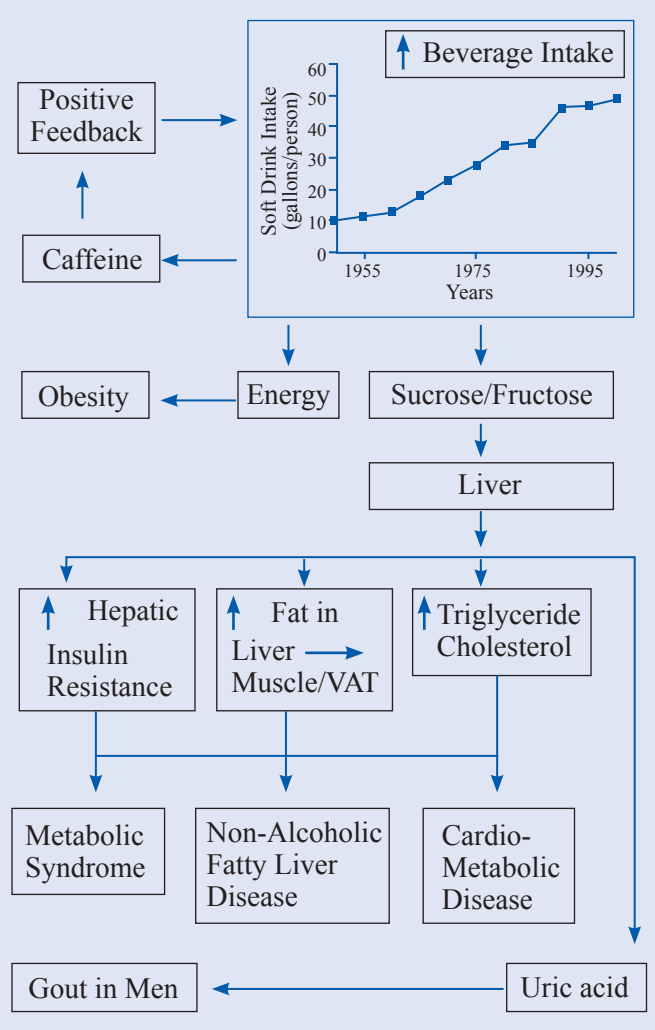

Figure 2. Illustrative model for some potential consequences of increasing fructose and energy intake from sugar or High Fructose Corn Syrup in beverages

into low (0% to <10% of total energy) and high (≥10% of total energy). Across various factors controlling for obesity, race, physical activity, smoking, maturation stage, age, and nutritional factors, low compared with high added sugar consumption was associated with a 0.26 mg/dL greater annual increase in HDL levels (P=0.02). Over the 10-year study period, the model predicted a mean increase of 2.2 mg/dL (P=0.04) among low consumers, and a 0.4 mg/dL decrease (P=0.4) among high consumers.

BP, blood lipids, and dietary intakes were obtained in a multiethnic pediatric sample aged 7–12 y of 122 European American, 106 African American, 84 Hispanic American and 8 mixed-race children participating in the Admixture Mapping of Ethnic and Racial Insulin Complex Outcomes (AMERICO) study a cross-sectional study conducted in the Birmingham, AL, metro area investigating the effects of racial-ethnic differences on metabolic and health outcomes cross- sectional association between added sugar (sugars not naturally occurring in foods) consumption in children, blood pressure (BP), and fasting blood lipids [triglycerides and total, low-density lipoprotein, and high-density lipoprotein (HDL) cholesterol]. that increased consumption of added sugars may be associated with adverse cardiovascular health factors in children, specifically elevated diastolic BP and triglycerides.

The cross-sectional association between added sugar (sugars not naturally occurring in foods) consumption in children, blood pressure (BP), and fasting blood lipids [triglycerides and total, low-density lipoprotein, and high-density lipoprotein (HDL) cholesterol] demonstrated that added sugars were positively associated with diastolic BP (P = 0.0462) and serum triglycerides (P = 0.0206). Sodium was not significantly associated with either measure of BP nor was dietary fat with blood lipids. HA children had higher triglycerides but lower added sugar consumption than did either the AA or EA children. The AA participants had higher BP and HDL but lower triglycerides than did either the EA or HA children. These data suggest that increased consumption of added sugars may be associated with adverse cardiovascular health factors in children, specifically elevated diastolic BP and triglycerides. Identification of dietary factors influencing cardiovascular health during childhood could serve as a tool to reduce cardiovascular disease risk.

A recent European study concluded that the consumption of just one sugar-sweetened drink a day increased the risk of type 2 diabetes by 22%. A recent longitudinal cohort study involving 175 countries showed that, for every additional 150 sugar based kilocalories consumed daily (typical of a can of cola), there was a massive 11-fold increase in the risk of developing type 2 diabetes independent of body mass index and physical activity level.

Drinking two sugar-sweetened beverages per day for 6 months induced features of the metabolic syndrome and fatty liver. Randomized, controlled trials in children and adults lasting from 6 months to 2 years have shown that

lowering the intake of soft drinks reduced weight gain. Genetic factors influence the weight gain when drinking soft drinks.

Study was conducted to determine the prevalence and behavioral determinants of overweight and obesity in school going adolescents. A total of 660 adolescents from affluent and non-affluent schools were evaluated. Prevalence of overweight and obesity was 9.8% and 4.8%, respectively. Prevalence of both overweight and obesity was higher among males. Statistically significant difference was found in prevalence of overweight and obesity among affluent schools (14.8% and 8.2%) and non-affluent schools (4.8% and 1.5%). Important determinants of overweight and obesity were increased consumption of fast food, low physical activity level and watching television for more than 2 h/day. The prevalence of obesity is high even in small cities. Dietary behavior and physical activity significantly affect weight of adolescent children.

The Calcutta Childhood Obesity Study demonstrated the prevalence of overweight and obesity and its associated factors among *Bengalee* children and adolescents in the Kolkata. Data from the Nielsen Homescan and product content were analysed for sweetener type using the Gladson Nutrition Database. Over 70% of all foods contain some amounts of added sugar, and consumption of soft drinks has increased fivefold since 1950. Meta-analyses suggest that consumption of sugar-sweetened beverages is related to the risk of diabetes, the metabolic syndrome and cardiovascular disease in adults and in children.

Summary and Conclusions

We need to reconsider consumption of dietary sugar based on the growing concern of obesity and type 2 diabetes. Meta-analyses suggest that consumption of sugar-sweetened beverages (SSBs) is related to the risk of diabetes, the metabolic syndrome, and cardiovascular disease. Drinking two 16-ounce SSBs per day for 6 months induced features of the metabolic syndrome and fatty liver.

Randomized controlled trials in children and adults lasting 6 months to 2 years have shown that lowering the intake of soft drinks reduced weight gain. Recent studies suggest a gene-SSB potential relationship.

A number of public health campaigns to limit intake of SSB's are underway and strategies such as taxation are currently being considered as a means of reducing intake levels as well as offsetting related health care costs. Thus amidst a growing pandemic of obesity, ample evidence exists to discourage consumption of these beverages in place of healthy alternatives such as water, to reduce risk of T2DM and CVD, and to improve overall health and quality of life the average US citizen was consuming a staggering 22 teaspoons of added sugar a day, greatly exceeding discretionary calorie allowances

Although a well balanced diet may contain intrinsic sugars in the form of whole fruit, vegetables, dairy products, and many grains, the body does not require any carbohydrate from added sugar.

The typical calorie allowance for a 4-8 year old child should be a maximum of three teaspoons a day. Although a well balanced diet may contain intrinsic sugars in the form of whole fruit, vegetables, dairy products, and many grains, the body does not require any carbohydrate from added sugar.

Since the American Heart Association publication, almost four years ago, several randomised controlled trials and observational studies have implicated sugar consumption with increasing rates of obesity and type 2 diabetes.

Despite the American Heart Association's statement and the supportive scientific evidence, the food industry continues to adopt strategies to deny sugar's role as a major causative factor in what now represents the greatest threat to our health worldwide: diet related disease. It took 50 years from the first publication linking smoking to lung cancer before the introduction of any effective legislation because Big Tobacco successfully adopted a strategy of denial, planting doubt, confusing the public, and even buying the loyalty of scientists, all at the cost of millions of lives. The same "corporate playbook" has been adopted by Big Food.

Foods that we perceive as junk are only half the problem. In the United States, a third of added sugar consumption comes from sugar sweetened drinks and a sixth comes from food items such as chocolates, ice creams, and biscuits, but half comes from foods that one wouldn't normally associate as having added sugar, such as

ketchup, salad dressings, and bread. Just as in the UK and Europe, US food labels contain information on total sugars per serving, but do not differentiate between sugars naturally present and added sugar.

It is therefore extremely difficult for consumers to determine the amount of added sugars in foods and beverages.

It is concerning that the US Department of Agriculture recently removed a published database for the added sugar content of selected foods stating "no method can analyse for added sugars so their amounts must be extrapolated or supplied by food companies, many of which are not willing to make public such proprietary information."One can of regular cola contains nine teaspoons of added sugar, which is triple the 2009 upper limit intake suggested by US Department of Agriculture for an 8 year old child

Snacking has steadily increased in this population since the 1970s, and snacks provide necessary nutrients. However, carbohydrates and added sugars tend to be over-consumed at snacking occasions. Replacement of current snack choices with nutrient-dense foods could lower the risks of nutrient deficiencies and help lower excess nutrient consumption. Increased consumption of low sugar dairy foods, especially yogurt, at snack times could increase intake of important micronutrients without contributing to dietary excesses

Consumption of calorie-sweetened beverages and the fructose they contain has continued to increase and may play a role in the epidemic of obesity, the metabolic syndrome and fatty liver disease. Reducing intake of soft drinks is associated with less weight gain and metabolic improvement as well. These recommendations are based on two principal facts:

The current surge in BMI and obesity began about 1975 and that calorically sweetened beverages, and possibly other sugar-containing foods, play a role in the development of obesity.

Recommendations for the individual:

1. Chose water, unsweetened coffee, or tea in place of calorically sweetened beverages
2. Chose and eat fruit rather than drink fruit juice or fruit drinks.
3. If you drink calorically sweetened beverages, reduce your levels to the average 6 ounces per day for adults (19 years) and 7 ounces for kids aged 2–18 years, which was the intake in 1977–1978.

Recommendations for society:

1. Reduce average intake of sugar to the levels seen in 1977–1978.
2. Make healthy alternatives comparable in cost to the items they are expected to replace
3. Treat caffeine as the "mildly addictive" drug that it is and limit its use as it may drive the intake of caffeinated beverages.

Recommendations for government:

1. Provide greater subsidies for vegetable and fruit crops.
2. Provide added financial incentives for government-funded food programs to increase fruit and vegetable consumption
3. Provide incentives for stores in low income areas to carry fresh produce.
4. Add guidance about beverages and sugar intake to Dietary Guidelines for Americans

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