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## The bitter side of high fructose corn syrup (HFCS) - the global obesity pandemic

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### Abstract

Sweet taste accompanies our lives since childhood. Sugar is commonly used in industrial production. Increased consumption of simple sugars has been observed since many years. Sugars come in different forms and one of them - glucose-fructose is on scientists aim because of its impact on health. Fructose has unique metabolic features, that could be harmful for human organism. Excessive consumption of this substance contributes to obesity pandemic, development of diabetes mellitus and cardiovascular disease. Obesity affects in particular children and teenagers.[1] High consumption of fructose disturb sense of hunger and satiety.

## **Fructose**

Fructose (chemical formula C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>) is a monosaccharide similar to glucose. It is a natural compound of honey, fruit and flower nectar. GLUT-5 transporter has high affinity to fructose and it takes part in passive absorption of it in intestine - process independent from insulin. This transporter is absent in brain or pancreas B cells - it means that fructose transport to those tissues is limited. Fructose doesn't cause satiety. It doesn't increase insulin release, at the same time it increases insulin tissue sensitivity. Fructose decreases postprandial leptin release that is responsible for long term energetic homeostasis regulation. It increases ghrelin (hunger hormone) secretion. Lower leptin and insulin concentration and elevated ghrelin level contribute to excessive eating and obesity.[2,3]

### **High fructose corn syrup (HFCS)**

High fructose corn syrup (HFCS) and sucrose are main sources of fructose in processed foods. HFCS is a sweetener made from corn starch using the process of enzymatic isomerization of glucose to fructose. It's widely used because of low price. HFCS is used as a sweetener in juices, sodas and foods like yoghurts, jams, bread and spices. Daily calorie intake increased during the last few years, and according to recent studies 50% comes from sweet drinks consumption.[4] Over the years HFCS use in the food industry increased. It has been proven that obesity, metabolic disorders and cardiovascular diseases are related to HFCS consumption. Furthermore HFCS rich products are considered as 'empty calories' - those supply mainly calories but no other nutrients (vitamins, protein, fiber, minerals).[5-8]

Fructose concentration in the most common HFCS forms used in the food industry are 42% or 55%:[9]

- HFCS-42: contains 42% of fructose (appeared in 1967) - it's used mostly in foods like jams, pastry, dairy and beer
- HFCS-55: contains 55% of fructose (introduced in 1977) - used mainly in soft drinks (carbonated and not carbonated) and juices

## **Obesity**

Obesity is one of the leading preventable causes of death worldwide. It is a medical condition in which excess body fat has accumulated to an extent that it may have a negative effect on health. It is correlated with various diseases: type 2 diabetes, cardiovascular diseases, obstructive sleep apnea.

To assess overweight and obesity we can use a measurement body mass index (BMI). BMI is obtained by dividing a person's weight by the square of the person's height [BMI = person's weight (kg) : square of the person's height (m<sup>2</sup>)]. High BMI may be a marker of risk

for diseases. People are generally considered obese when their body mass index is over 30 kg/m<sup>2</sup>.

<b>BMI (kg/m<sup>2</sup>)</b>	<b>Classification</b>
17,0–18,49	underweight
18,5–24,9	normal weight
25–29,9	overweight
30,0–34,99	class I obesity
35,0–39,99	class II obesity
≥ 40,0	class III obesity

Tab. 1 Adult body weight classification based on body mass index, BMI [10] (some East Asian countries use lower values)

Ludwig et al. showed that consumption of sugar-sweetened beverages (SSB) is associated with obesity in children. In a prospective cohort study they measured the association between the intake of SSB and change in BMI, in a group of 548 children for 19 months. The risk of obesity [odds ratio (OR) 1.60; 95% confidence interval (CI), 1.14-2.24; p=0.02] was significantly increased in children with increased SSB intake, after adjustment for demographic, dietary and lifestyle variables.[11] Kosova et al. made a cross-sectional analysis of National Health and Nutrition Examination Survey (NHANES) during 1999-2004, data collection by the National Center for Health Statistics. They evaluated the relationship between sugar-sweetened beverage intake and cardio metabolic markers in a group of 4880 children at age of 3-11. The association between SSB intake and BMI percentile was not significant (P = 0.07).[12]

Ambrosini et al. examined an association between SSB intake and obesity measured by change of BMI. They followed a group of 1433 adolescent offspring from Western Australian Pregnancy Cohort study. Girls (n=600) who were moved into the top tertile of SSB consumption had significantly greater changes in BMI. No significant association was observed in boys (n=706). [13] Bremer et al. examined the association between SSB intake and BMI in groups of adolescents at age of 12-19. Based on information derived from NHANES questionnaire, subjects were classified as: non-Hispanic black, non-Hispanic white and Mexican American. There was a significant association between SSB intake and BMI among Mexican Americans and non-Hispanic whites (p<0.05), after adjustment for total energy intake, age and physical activity.[14]

Bermudez and Gao also found a significant correlation between SSB intake and incidence of obesity, after adjustment for age, total energy intake and physical activity. This study included 947 US adults at age of 20-39 years old.[15] Higher intake of SSB was significantly associated with a increased incidence of obesity in Dhingra et al. prospective cohort study that included 4277 US adults.[16]

## Summary

High sugar diet is responsible for many health problems. Epidemic studies showed that high fructose diet is related to cardiovascular and metabolic diseases. Despite a lot of research proved negative influence of HFCS on human health its use is not restricted. HFCS has GRAS status (generally recognized as safe) - it means that it's considered as safe food ingredient. Nutritional education is important to decrease HFCS negative effects on health.

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