Sugar — the bitter truth

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The CDC says that the childhood obesity epidemic is slowing down—


But is it?


But is it?

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So is the epidemic of childhood obesity really slowing down?

- The prevalence of obesity amongst Whites is decreasing, but amongst Blacks and Latinos (and Asians) is increasing.
- Minorities compose an increasing percentage of American children annually.
- This JAMA paper analyzed mean data from all ages 2-19; but in the 2-5 year old age range, things are just getting worse.

The First Law of Thermodynamics

Weight Gain

Calories Out

Calories In

Cheap food?

Total Caloric Intake

↑ 275 kcal in teen boys

Fat Intake: Grams

↑ 5 g (45 cal) in teen boys

Prevalence of Obesity Compared to Percent Calories from Fat Among US Adults

Children 2-17 yrs, CSFII (USDA) 1989-91 vs. 1994-95

http://www.usda.gov/cnpp/eoh%20Y1991%20y11n3p44.PDF
Carbohydrate Intake: Grams

- ↑ 57 g (228 cal) in teen boys

Children 2-17 yrs, CSFII (USDA) 1989-91 vs. 1994-95

Beverage Intake

- ↑41% soft drinks
- ↑35% fruit drinks

Children 2-17 yrs, CSFII (USDA) 1989-91 vs. 1994-95

Meta-Analysis of Soft Drinks and Obesity

- 88 cross-sectional and longitudinal studies regressing soft drink consumption with —
  - energy intake: $r = 0.16$ ($P < 0.001$)
  - body weight: $r = 0.08$ ($P < 0.001$)
  - milk and calcium intake: $r = -0.12$ ($P < 0.001$)
  - adequate nutrition: $r = -0.10$ ($P < 0.001$)

Those studies funded by the beverage industry demonstrated smaller effects than independent studies.

Curtailing soft drinks limits childhood obesity

- One can of soda/day = 150 cal x 365 d/yr ÷ 3500 cal/lb = 15.6 lbs/yr

High Fructose Corn Syrup

- Current US annual consumption of HFCS: 63 pounds per person
High Fructose Corn Syrup is 42-55% Fructose; Sucrose is 50% Fructose

Sucrose Fructose Glucose

USA Today, Dec 9, 2008 P. 7D

Unlikely Duo Opposes San Francisco Soft Drink Tax Plan

Corn Refiners and CSPI Agree High-Fructose Corn Syrup No Worse Than Sugar

WASHINGTON—The nonprofit Center for Science in the Public Interest has long supported small taxes on soft drinks to help pay for bike paths, nutrition education, and other obesity-prevention programs. But CSPI opposes a measure proposed by San Francisco Mayor Gavin Newsom because it would tax only drinks made with high-fructose corn syrup and not drinks made with other forms of sugar. Less surprisingly, the Corn Refiners Association also opposes the measure, but the two groups cosigned an unusual joint letter to Mayor Newsom urging him to reconsider his plan.

“We respectfully urge that the proposal be revised as soon as possible to reflect the scientific evidence that demonstrates no material differences in the health effects of high-fructose corn syrup and sugar,” wrote CSPI executive director Michael F. Jacobson and Corn Refiners Association president Audrae Erickson.

“The real issue is that excessive consumption of any sugars may lead to health problems.”

The letter goes on to explain that high-fructose corn syrup and sucrose, or table sugar, are similar in composition and that several studies have shown that the two types of sugars are similarly metabolized by the body.

Secular trend in fructose consumption

Natural consumption of fruits and vegetables
• 15 gm/day

Prior to WWII (estimated):
• 16-24 gm/day

1977-1978 (USDA Nationwide Food Consumption Survey):
• 37 gm/day (8% of total caloric intake)

1994 (NHANES III):
• 54.7 gm/day (10.2% of total caloric intake)

Adolescents:
• 72.8 gm/day (12.1% of total caloric intake)
• 25% consumed at least 15% of calories from fructose


The perfect storm from three political winds

1. Richard Nixon and USDA Secretary Earl Butz (1973)
• food should never be an issue in a presidential election
The perfect storm from three political winds

1. Richard Nixon and USDA Secretary Earl Butz (1973)
   - food should never be an issue in a presidential election

2. The advent of High Fructose Corn Syrup
   - invented in 1966 in Japan
   - introduced to the American market in 1975

3. The USDA, AMA, and AHA call for dietary fat reduction
   - Early 1970’s: discovery of LDL
   - Mid 1970’s: Dietary fat raises LDL (A \rightarrow B)
   - Late 1970’s: LDL correlated with CVD (B \rightarrow C)
   - 1982: If A \rightarrow B, and B \rightarrow C, then A \rightarrow C, therefore no A, no C
The macronutrient wars 1970-1980

Seven Countries
Correlation of CHD with dietary fat

Adulteration of our food supply

Fructose is not glucose

The content of low-fat home-cooked food can be controlled
But low-fat processed food means substitution with carbohydrate
Which carbohydrate?
Either
• High fructose corn syrup (55% fructose)
• Sucrose (50% fructose)
e.g. Nabisco Snackwells® Oreos
(→2g fat, +13g CHO (+4g sugars))

Addition of fructose
• palatability (esp. with decreased fat)
• browning agent

Removal of fiber
• shelf life
• freezing

Substitution of trans-fats
• hardening agent, shelf life
• now being removed due to CVD risk

Fructose is 7 times more likely than glucose to form Advanced Glycation End-Products (AGE’s)
Fructose does not suppress ghrelin
Acute fructose does not stimulate insulin (or leptin)
Hepatic fructose metabolism is different
Chronic fructose exposure promotes the Metabolic Syndrome

Elliot et al. Am J Clin Nutr, 2002
Rutledge and Adeli, Nutr Rev, 2007
Bhanot et al. J Clin Endocrinol Metab, 2004
Li and Tappy, Curr Opin Clin Nutr Metab Care, 2006
Wu et al. J Nutr, 2006
Teff et al. J Clin Endocrinol Metab, 2004
Wei et al. J Nutr Biochem, 2006
Bray et al. Am J Clin Nutr, 2004
Elliot et al. Am J Clin Nutr, 2002
Gaby, Alt Med Rev, 2005
Le and Le, Curr Opin Clin Nutr Metab Care, 2006

The low-fat craze

Seven Countries
Correlation of CHD with dietary fat

The macronutrient wars 1970-1980
Ethanol is a carbohydrate

CH$_3$-CH$_2$-OH

But ethanol is also a toxin

Acute ethanol exposure
- CNS depression
- Vasodilatation, decreased BP
- Hypothermia
- Tachycardia
- Myocardial depression
- Variable pupillary responses
- Respiratory depression
- Diuresis
- Hypoglycemia
- Loss of fine motor control

Acute fructose exposure
60 kcal
(+ 12 kcal glucose)

48 kcal
Relations between fructose, uric acid and hypertension in NHANES IV adolescents

\[ P = 0.01 \]

\[ P = 0.0495 \]
Fructose increases de novo lipogenesis in normal adults


Fructose increases de novo lipogenesis, triglycerides, and free fatty acids in normal adults

Faeh and Schwarz, Diabetes 54:1907, 2005

Detrimental Effects of Fructose

Associations between sugar sweetened beverage consumption and ALT in obese children

Vanier et al. [cited above]
**Why is exercise important in obesity?**

Because it burns calories?

Because it improves skeletal muscle insulin sensitivity

Because it reduces stress, and resultant cortisol release

Because it makes the TCA cycle run faster, and detoxifies fructose, improving hepatic insulin sensitivity

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**So what’s with Colorado?**

Four factors increase the hepatic TCA cycle

- Cold
- Altitude
- Thyroid hormone
- Exercise

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**Why is fiber important in obesity?**
Why is fiber important in obesity?

“When G-d made the poison, he packaged it with the antidote.”

Fiber:
1. Reduces rate of intestinal carbohydrate absorption, reducing insulin response
2. Increases speed of transit of intestinal contents to ileum, to raise PYY3-36, and induce satiety
3. Inhibits absorption of some free fatty acids to the colon, which are metabolized by colonic bacteria to short-chain fatty acids (SCFA), which suppress insulin

Chronic ethanol exposure
- Hematologic disorders
- Electrolyte abnormalities
- Hypertension
- Cardiac dilatation
- Cardiomyopathy
- Dyslipidemia
- Pancreatitis
- Malnutrition
- Obesity
- Hepatic dysfunction (ASH)
- Fetal alcohol syndrome
- Addiction

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What’s the difference?

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<td>Percent CHO</td>
<td>10.5% (sucrose)</td>
<td>3.6% (alcohol)</td>
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<tr>
<td>Calories from fructose</td>
<td>75 (4.1 kcal/gm)</td>
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<td>other carbs</td>
<td>75 (glucose)</td>
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<td>alcohol</td>
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<tr>
<td>1st pass GI metabolism</td>
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<td>Calories reaching liver</td>
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**Fructose is a carbohydrate**

**Fructose is metabolized like fat**

**Fructose is a carbohydrate**

**Fructose is metabolized like fat**

(corollary: a low fat diet isn’t really low fat, because the fructose/sucrose doubles as fat)

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**Summary**

- Fructose (sucrose vs. HFCS) consumption has increased in the past 30 years, coinciding with the obesity epidemic
- A calorie is not a calorie, and fructose is not glucose
- You are not what you eat, you are what you DO with what you eat
- Hepatic fructose metabolism leads to all the manifestations of the Metabolic Syndrome:
  - hypertension
  - de novo lipogenesis, dyslipidemia, and hepatic steatosis
  - inflammation
  - hepatic insulin resistance
  - obesity
  - hyperglycemia
  - CNS leptin resistance, promoting reward and continuous consumption
- Fructose is a dose-dependent chronic hepatotoxin (it’s “alcohol without the buzz”)
Childhood Obesity 2010:
The next generation in prevention and management

- SF Childhood Obesity Task Force
- Sponsored by SF Dept. of Public Health
- Training Day for Childhood Obesity
- Saturday, Feb. 27, 2010, 8AM-5PM
- Milton Marks Auditorium (Civic Center)
- State of the art
- Theory, and tools to use in practice
- CME offered

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