Sugar-Sweetened Beverages and Health

CIA-Harvard Menus of Change®
National Leadership Summit

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Harvard School of Public Health
What are Sugar-Sweetened Beverages?

**Examples**

<table>
<thead>
<tr>
<th>Sodas</th>
<th>Fruit Drinks</th>
<th>Energy Drinks</th>
<th>Sports Drinks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coke ®</td>
<td>Capri Sun ®</td>
<td>Adrenaline Rush ®</td>
<td>Gatorade ®</td>
</tr>
<tr>
<td>Pepsi ®</td>
<td>Fruitopia ®</td>
<td>Full Throttle ®</td>
<td>Powerade ®</td>
</tr>
<tr>
<td>Mountain Dew ®</td>
<td>Hawaiian Punch ®</td>
<td>MDX ®</td>
<td></td>
</tr>
<tr>
<td>Orange Soda</td>
<td>Hi-C ®</td>
<td>No Fear ®</td>
<td></td>
</tr>
<tr>
<td>Root Beer</td>
<td>Kool-Aid ®</td>
<td>RockStar ®</td>
<td></td>
</tr>
<tr>
<td>Sprite ®</td>
<td>Minute Maid ®</td>
<td>EnergyVault ®</td>
<td></td>
</tr>
<tr>
<td>7-Up ®</td>
<td>Snapple juices ®</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SSBs Ingredients

• Energy: 12-14 kcal/ounce or ~120-150 kcal/12 ounce can

• Sugars: 3.1-3.6 g/ounce (~10 tsp/12 ounce can)

Sweetened by

US: High fructose corn syrups (55% fructose and 42% glucose)

Europe: Sucrose (50% fructose and 50% glucose)
Sugar-Sweetened Beverage Consumption

- Energy in liquid form
- Displacement of more satiating foods
- High glycemic load
- Alteration of taste preferences

- Incomplete calorie compensation
- Passive calorie overconsumption when drinking to satisfy thirst
- Increased hunger
- Increased energy intake

- Postprandial hyperglycemia & hyperinsulinemia
- Insulin resistance
- B-cell dysfunction

- Metabolic Syndrome
  (low HDLC, high triglyceride, hypertension, hyperglycemia coagulopathy, chronic inflammation)

- Increased intake of sugary foods; decreased intake of vegetables, fruits, etc

- Lower intake of fiber micronutrients, antioxidants and other phytochemicals

- Obesity
- Diabetes
- CHD
- Dental caries

29.273
Nurses’ Health Study (n=121,700)

Health Professionals Follow-up Study (n=52,000)

Nurses’ Health Study II (n=116,000)

Investigators: Frank Speizer, Bernie Rosner, Meir Stampfer, Graham Colditz, David Hunter, JoAnn Manson, Sue Hankinson, Eric Rimm, Edward Giovannucci, Alberto Ascherio, Gary Curhan, Charlie Fuchs, Fran Grodstein, Michelle Holmes, Frank Hu
Sugar-Sweetened Beverages and Weight Gain in Children and Adults: A Systematic Review and Meta-Analysis

9833 Citations identified from PubMed, EMBASE and Cochrane databases

9773 Citations excluded based on screening of titles or abstracts

60 Potentially relevant articles identified for full-text review

5 Articles identified from reference lists

33 Articles excluded based on full text screening by inclusion criteria

20 Articles in Meta-Analysis in Children:
15 Prospective cohort studies; 5 Trials

12 Articles in Meta-Analysis in Adults:
7 Prospective cohort studies; 5 Trials

Malik et al. AJCN 2013
Children: All Cohort Studies

Change in BMI (95% CI) per 1 serving per day increase in SSB during the time period specified in each study, from prospective cohort studies in children
Children: RCTs

Weighted mean difference in BMI change (95% CI) between intervention and control regimens from RCT’s in children. Interventions evaluated the effect of reducing SSB.
1-year change in weight (kg) per 1 serving per day increase in SSB, from prospective cohort studies in adults using a change vs. change analysis strategy
Changes in Food and Beverage Consumption and Weight Changes Every 4 Years, According to Study Cohort

(Mozaffarian D et al., NEJM 2011)
Weighted mean difference in weight change (kg) between intervention and control regimens from RCT’s in adults. Interventions evaluated the effect of adding SSB
Relative Risk of Type 2 Diabetes with Sugar-Sweetened Soft Drink Consumption

- **<1/mo**: 1.00
- **1-4/mo**: 1.06
- **2-6/wk**: 1.11
- **>=1/d**: 1.50

**P<0.001 for trend**

Sugar-sweetened soft drink consumption is associated with an increased risk of Type 2 Diabetes. The risk is higher for more frequent consumption, with a multivariate adjustment showing a significant increase compared to the baseline category. Further adjustment for BMI does not alter the trend.

*(Schulze et al. 2004)*
Meta-Analysis of Prospective Studies on Sugar-Sweetened Beverages and Risk of Type 2 Diabetes

Malik et al. Diabetes Care 2010
RR for Sweetened Beverages & Risk of CHD

Quintiles of Sweetened Beverage

- <1/mo
- 1-4/mo
- 2-6/wk
- 1- <2/d
- 2+/d

Relative Risk of CHD

P=0.004

(Fung et al. 2008)
## Adjusted HRs of CVD Mortality by Categories of SSBs Consumption NHANES 1988-2006

<table>
<thead>
<tr>
<th>Servings of SSBs Consumption Per Week</th>
<th>&lt;1</th>
<th>1 to &lt;3</th>
<th>3 to &lt;7</th>
<th>≥7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age-sex-race adjusted HRs</td>
<td>1.00</td>
<td>0.99 (0.70 - 1.38)</td>
<td>1.01 (0.73 - 1.38)</td>
<td>1.37 (1.09 - 1.71)</td>
</tr>
<tr>
<td>Fully Adjusted*</td>
<td>1.00</td>
<td>1.04 (0.74 - 1.46)</td>
<td>1.05 (0.74 - 1.49)</td>
<td>1.32 (1.04 - 1.66)</td>
</tr>
</tbody>
</table>

* Adjusted for age, sex, race/ethnicity, education, smoking status, alcohol consumption, BMI, physical activity, family history of CVD, Healthy Eating Index, antihypertensive medication use, systolic blood pressure, total cholesterol, and total calorie intake
Conclusions:

- Adverse effects of soda/SSB consumption on risks of obesity, diabetes, heart disease, gout, and dental caries well documented.
- Tide has turned in the US, and soda consumption is declining.
- Big soda, like big tobacco, is looking elsewhere for future growth.
- Nevertheless, big soda still uses every tactic possible to promote sales in US and obstruct public health progress.
- Food services can play a critical role by offering attractive alternative beverages.
SSB and BMI in Children

Change in BMI per 1 serving/d increase in SSB, during the time period specified for each study

### SSB and BMI in Children: Re-analysis

<table>
<thead>
<tr>
<th>Study</th>
<th>ES (95% CI)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ludwig, 2001</td>
<td>0.20 (0.10, 0.30)</td>
<td>8.09</td>
</tr>
<tr>
<td>Berkey, 2004 Males</td>
<td>0.03 (0.00, 0.06)</td>
<td>18.93</td>
</tr>
<tr>
<td>Berkey, 2004 Females</td>
<td>0.02 (-0.00, 0.04)</td>
<td>19.43</td>
</tr>
<tr>
<td>James, 2004</td>
<td>0.10 (-0.10, 0.30)</td>
<td>3.20</td>
</tr>
<tr>
<td>Newby, 2004</td>
<td>-0.12 (-0.59, 0.35)</td>
<td>0.64</td>
</tr>
<tr>
<td>Phillips, 2004</td>
<td>0.18 (0.07, 0.28)</td>
<td>8.01</td>
</tr>
<tr>
<td>Blum, 2005</td>
<td>-0.08 (-0.28, 0.13)</td>
<td>2.94</td>
</tr>
<tr>
<td>Ebbeling, 2006</td>
<td>0.14 (-0.27, 0.55)</td>
<td>0.82</td>
</tr>
<tr>
<td>Mundt, 2006 Males</td>
<td>-0.06 (-0.13, 0.01)</td>
<td>12.49</td>
</tr>
<tr>
<td>Mundt, 2006 Females</td>
<td>-0.09 (-0.20, 0.02)</td>
<td>7.83</td>
</tr>
<tr>
<td>Striegel-Moore, 2006</td>
<td>0.04 (0.00, 0.08)</td>
<td>17.63</td>
</tr>
<tr>
<td>Overall (I-squared = 68.5%, p = 0.000)</td>
<td>0.03 (-0.00, 0.07)</td>
<td>100.00</td>
</tr>
</tbody>
</table>

**NOTE:** Weights are from random effects analysis

Fixed Effects: 0.03 (0.01, 0.04)

## SSB and BMI in Children: Re-analysis, Removing Studies that Adjusted for Total Energy

### Study Results

<table>
<thead>
<tr>
<th>Study</th>
<th>ES (95% CI)</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ludwig, 2001</td>
<td>0.20 (0.10, 0.30)</td>
<td>14.21</td>
</tr>
<tr>
<td>Berkey, 2004 Males</td>
<td>0.03 (0.00, 0.06)</td>
<td>31.85</td>
</tr>
<tr>
<td>Berkey, 2004 Females</td>
<td>0.02 (-0.00, 0.04)</td>
<td>32.63</td>
</tr>
<tr>
<td>James, 2004</td>
<td>0.10 (-0.10, 0.30)</td>
<td>5.74</td>
</tr>
<tr>
<td>Phillips, 2004</td>
<td>0.18 (0.07, 0.28)</td>
<td>14.08</td>
</tr>
<tr>
<td>Ebbeling, 2006</td>
<td>0.14 (-0.27, 0.55)</td>
<td>1.49</td>
</tr>
<tr>
<td><strong>Overall</strong> (I-squared = 73.5%, p = 0.002)</td>
<td><strong>0.08 (0.03, 0.13)</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

**NOTE:** Weights are from random effects analysis

**Fixed Effects:** 0.03 (0.02, 0.05)
Drinking caloric beverages increases the risk of cardiometabolic outcomes in the Coronary Artery Risk Development in Young Adults (CARDIA) Study. N= 2774, 20 yr follow-up.

<table>
<thead>
<tr>
<th>Health Indicator</th>
<th>RR (95% CI)</th>
<th>P trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>High WC</td>
<td>1.09 (1.04, 1.15)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>High Fasting glucose</td>
<td>1.03 (0.95, 1.12)</td>
<td>0.4600</td>
</tr>
<tr>
<td>High TG</td>
<td>1.06 (1.01, 1.13)</td>
<td>0.033</td>
</tr>
<tr>
<td>High LDL</td>
<td>1.18 (1.02, 1.36)</td>
<td>0.018</td>
</tr>
<tr>
<td>Low HDL</td>
<td>1.06 (0.97, 1.16)</td>
<td>0.192</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1.06 (1.01, 1.12)</td>
<td>0.023</td>
</tr>
</tbody>
</table>

RR associated with each increase in quartile of SSB consumption.

Parallel, 10 wks: Sucrose-rich diet increased postprandial glucose, insulin, and lipids compared artificial sweeteners in overweight healthy subjects.  
Food Nutr Res 2011;55.

Parallel, 10-wks: Sucrose-rich diet increased serum levels of haptoglobin, transferrin and CRP compared artificial sweetener in overweight healthy subjects.  
Am J Clin Nutr 2005;82(2):421-7

Cross-over, 3 wks: SSB (fructose, sucrose) consumed in small to moderate quantities impaired glucose and lipid metabolism and promoted inflammation in normal-weight healthy men.  
Am J Clin Nutr 2011;94(2):479-85