Processed food: An experiment that failed

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Swedish Hospital, Jan. 27, 2017
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FAT Chance
Beating the Odds Against SUGAR, PROCESSED FOOD, OBESITY and DISEASE
Robert H. Lustig M.D.
A Failed Experiment

By DAVID von DRIESCH

The penalty is modern death. Three more executions. Backlogged courts. And Bundled executions.
Imagine the last 50 years was an experiment

The food industry posed the hypothesis:

**Processed food is better than real food.**

Outcomes:

- Consumption
- Health/Disease
- Environment
- Cash flow
  - companies
  - consumers
  - society
The experiment

1965
The experiment

1966

2016
Ten conglomerates
Processed food

- Has to be mass produced
- Has to be consistent batch to batch
- Has to be consistent country to country
- Specialized ingredients from specialized companies
- Virtually all macronutrients are pre-frozen
  - Which means that the fiber is usually removed
- Has to stay emulsified (fat and water don’t separate)
- Has to have long shelf-life or freezer life
The difference between processed food and real food
The difference between processed food and real food

Not enough:

Fiber
The difference between processed food and real food

Not enough:

Fiber
Omega-3 fatty acids (wild fish)
The difference between processed food and real food

Not enough:

Fiber
Omega-3 fatty acids (wild fish)
Micronutrients
The difference between processed food and real food

Not enough:

- Fiber
- Omega-3 fatty acids (wild fish)
- Micronutrients

Too much:

- Trans-fats
The difference between processed food and real food

Not enough:
- Fiber
- Omega-3 fatty acids (wild fish)
- Micronutrients

Too much:
- Trans-fats
- Branched chain amino acids (leucine, isoleucine, valine)
The difference between processed food and real food

Not enough:

Fiber
Omega-3 fatty acids (wild fish)
Micronutrients

Too much:

Trans-fats
Branched chain amino acids (leucine, isoleucine, valine)
Omega-6 fatty acids (plant oils, polyunsaturates)
The difference between processed food and real food

Not enough:

- Fiber
- Omega-3 fatty acids (wild fish)
- Micronutrients

Too much:

- Trans-fats
- Branched chain amino acids (leucine, isoleucine, valine)
- Omega-6 fatty acids (plant oils, polyunsaturates)
- Additives
The difference between processed food and real food

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- Micronutrients

Too much:

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- Additives
- Emulsifiers (polysorbate-80, carboxymethylcellulose)
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- Additives
- Emulsifiers (polysorbate-80, carboxymethylcellulose)
- Salt
The difference between processed food and real food

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- Micronutrients

Too much:

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- Additives
- Emulsifiers (polysorbate-80, carboxymethylcellulose)
- Salt
- Nitrates, Heme (processed red meat)
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Not enough:

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Too much:

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- Branched chain amino acids (leucine, isoleucine, valine)
- Omega-6 fatty acids (plant oils, polyunsaturates)
- Additives
- Emulsifiers (polysorbate-80, carboxymethylcellulose)
- Salt
- Nitrates, Heme (processed red meat)
- SUGAR!
Addictive and hazardous to your health
Addictive and hazardous to your health
Sugar is 'addictive and the most dangerous drug of the times'

Soft drinks should carry tobacco-style warnings that sugar is highly addictive and dangerous, a senior Dutch health official has warned.

By Bruno Waterfield
11:13AM BST 17 Sep 2013  The Telegraph, London, UK

Paul van der Velpen, the head of Amsterdam’s health service, the Dutch capital city where the sale of cannabis is legalised, wants to see sugar tightly regulated.

"Just like alcohol and tobacco, sugar is actually a drug. There is an important role for government. The use of sugar should be discouraged. And users should be made aware of the dangers," he wrote on an official public health website.
Our sugar craving is evolutionary

Sweet-Ease increases endogenous opioids to reduce pain, Even in neonates
Of the 600,000 items in the American food supply, 74% have added sugar (sucrose, HFCS)

Ng et al. J Acad Nutr Diet 112:1828, 2012
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Of 4,000 packaged items in the American food supply, 50% have greater than the recommendation for added salt

Lee et al. Preventing Chronic Disease, epub Apr 2, 2015 doi: 10.5888/pcd12.140500
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Of 4,000 packaged items in the American food supply, 50% have greater than the recommendation for added salt

Lee et al. Preventing Chronic Disease, epub Apr 2, 2015 doi: 10.5888/pcd12.140500

Therefore, sugar is the marker for processed food
Consumption
The evolution of fast food

1957
FAST FOOD HAMBURGER
1 OZ.
210 calories

Today
FAST FOOD HAMBURGER
6 OZ.
618 calories

Thickburger
1420 calories
Children 2-17 yrs, CSFII (USDA) 1989-91 vs. 1994-95
http://www.usda.gov/cnpp/FENR%20V11N3/fenrv11n3p44.PDF

Total Caloric Intake

↑ 275 kcal in teen boys
Fat Intake: Grams

↑ 5 g (45 cal) in teen boys

Children 2-17 yrs, CSFII (USDA) 1989-91 vs. 1994-95
Secular trends in specific food intake
1989-1996

Prevalence of Obesity Compared to Percent Calories from Fat Among US Adults
Carbohydrate Intake: Grams

↑ 57 g (228 cal) in teen boys

Children 2-17 yrs, CSFII (USDA) 1989-91 vs. 1994-95
Secular trends in specific food intake
1989-1996

Fats

CHO

Beverage Intake

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

↑41% soft drinks

↑35% fruit drinks
High Fructose Corn Syrup

Current US annual consumption of HFCS

• 63 pounds per person

Users:
U.S., Canada, Japan, Europe
(limited exposure)
High Fructose Corn Syrup is 42-55% Fructose; Sucrose is 50% Fructose

Glucose

Fructose

Sucrose
The Coca-Cola Conspiracy

1955
10 oz
13 lb/yr

1915
6.5 oz
8 lb/yr

1988
44 oz
57 lb/yr

1960
12 oz
16 lb/yr

1992
20 oz
26 lb/yr
US Sugar Consumption, 1822-2005

- Growth of Sugar Industry
- Stabilization
- WWII
- HFCS + Sugar for Fat
- PROCESSED FOOD

U.S. Commerce Service 1822-1910, combined with Economic Research Service, USDA 1910-2010
http://ushealthcarespending.gov
Health/Disease
Decrease in U.S. Deaths from Heart Disease 1980–2000: offset by Type 2 Diabetes — and they’re not dying!


<table>
<thead>
<tr>
<th>Risk Factor†</th>
<th>Absolute Level of Risk Factor‡</th>
<th>Change in Risk Factor</th>
<th>Beta Regression Coefficient for Change in Mortality Rate§</th>
<th>Relative Risk</th>
<th>Best Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1980</td>
<td>2000</td>
<td>Relative Change (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking prevalence (%)</td>
<td>36.3</td>
<td>24.6</td>
<td>-11.7</td>
<td>32.2</td>
<td>-32.2</td>
</tr>
<tr>
<td>Men</td>
<td></td>
<td></td>
<td></td>
<td>2.52</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td></td>
<td></td>
<td></td>
<td>2.14</td>
<td></td>
</tr>
<tr>
<td>Systolic blood pressure (mm Hg)</td>
<td>119.0</td>
<td>123.9</td>
<td>-5.1</td>
<td>-4.0</td>
<td>-0.0134</td>
</tr>
<tr>
<td>Men</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.0134</td>
</tr>
<tr>
<td>Women</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.0413</td>
</tr>
<tr>
<td>Total cholesterol (mmol/liter)</td>
<td>5.67</td>
<td>5.33</td>
<td>-0.34</td>
<td>-6.1</td>
<td>-0.0413</td>
</tr>
<tr>
<td>Men</td>
<td></td>
<td></td>
<td></td>
<td>-0.9458</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td></td>
<td></td>
<td></td>
<td>-0.9121</td>
<td></td>
</tr>
<tr>
<td>Physical inactivity (%)</td>
<td>29.6</td>
<td>27.3</td>
<td>-2.3</td>
<td>-7.8</td>
<td>—</td>
</tr>
<tr>
<td>Men</td>
<td></td>
<td></td>
<td></td>
<td>1.27</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td></td>
<td></td>
<td></td>
<td>1.33</td>
<td></td>
</tr>
<tr>
<td>BMI</td>
<td>25.6</td>
<td>28.2</td>
<td>+2.6</td>
<td>10.1</td>
<td>0.0297</td>
</tr>
<tr>
<td>Men</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0297</td>
</tr>
<tr>
<td>Women</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.0297</td>
</tr>
<tr>
<td>Diabetes prevalence (%)</td>
<td>6.5</td>
<td>9.4</td>
<td>+2.9</td>
<td>44.2</td>
<td>—</td>
</tr>
<tr>
<td>Men</td>
<td></td>
<td></td>
<td></td>
<td>1.93</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td></td>
<td></td>
<td></td>
<td>2.39</td>
<td></td>
</tr>
<tr>
<td>Total risk factors</td>
<td></td>
<td></td>
<td></td>
<td>149,635</td>
<td></td>
</tr>
</tbody>
</table>
The Fiction

“Beating obesity will take action by all of us, based on one simple common sense fact: All calories count, no matter where they come from, including Coca-Cola and everything else with calories…”

The Science

• Some Calories Cause Disease More than Others

• Different Calories are Metabolized Differently

• A Calorie is Not A Calorie
Hazard ratio for CV mortality based on percent calories as sugar for US adult population, 1988-2006

Figure 1. Adjusted Hazard Ratio of the Usual Percent of Calories from Added Sugar for CVD Mortality Among US Adults Aged ≥20 Years – NHANES Linked Mortality Files, 1988-2006

Histogram is the distribution of usual percent of calories from added sugar in population. Lines show the adjusted HRs from Cox models. Mid-value of quintile 1 (7.5%) was the reference standard. Model was adjusted for age, sex, race/ethnicity, educational attainment, smoking status, alcohol consumption, physical activity level, family history of CVD, antihypertensive medication use, health eating index score, body mass index, systolic blood pressure, total serum cholesterol and total calories. Solid line indicates point estimates; dashed lines indicate 95% CIs. CVD indicates cardiovascular disease; HR, hazard ratio; NHANES, National Health and Nutrition Examination Survey.

## SSB’s and BMI-adjusted risk of diabetes in EPIC-InterAct (Europe)

<table>
<thead>
<tr>
<th>Variable and model</th>
<th>HR (95% CI)</th>
<th>1–4 glasses*/ month</th>
<th>&gt;1–6 glasses*/ month</th>
<th>≥1 glass*/ day</th>
<th>p for trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Juices and nectars (median intake, g/day)</td>
<td>(0.0)</td>
<td>(17.1)</td>
<td>(100.0)</td>
<td>(338.3)</td>
<td>0.064</td>
</tr>
<tr>
<td>No. cases</td>
<td>5,837</td>
<td>1,702</td>
<td>3,425</td>
<td>720</td>
<td></td>
</tr>
<tr>
<td>Crude model</td>
<td>1.00 (ref)</td>
<td>0.88 (0.80, 0.98)</td>
<td>0.89 (0.83, 0.94)</td>
<td>0.97 (0.85, 1.11)</td>
<td>0.64</td>
</tr>
<tr>
<td>Adjusted model</td>
<td>1.00 (ref)</td>
<td>0.91 (0.80, 1.02)</td>
<td>0.96 (0.88, 1.04)</td>
<td>1.00 (0.87, 1.15)</td>
<td>0.63</td>
</tr>
<tr>
<td>Adjusted model+EI</td>
<td>1.00 (ref)</td>
<td>0.91 (0.81, 1.02)</td>
<td>0.96 (0.88, 1.04)</td>
<td>0.99 (0.86, 1.14)</td>
<td>0.84</td>
</tr>
<tr>
<td>Adjusted model+EI+BMI</td>
<td>1.00 (ref)</td>
<td>0.97 (0.86, 1.10)</td>
<td>1.04 (0.96, 1.13)</td>
<td>1.06 (0.90, 1.25)</td>
<td>0.21</td>
</tr>
<tr>
<td>Total soft drinks* (median intake, g/day)</td>
<td>(0.0)</td>
<td>(20.0)</td>
<td>(95.1)</td>
<td>(413.1)</td>
<td></td>
</tr>
<tr>
<td>No. cases</td>
<td>5,794</td>
<td>1,604</td>
<td>2,987</td>
<td>1,299</td>
<td></td>
</tr>
<tr>
<td>Crude model</td>
<td>1.00 (ref)</td>
<td>1.21 (1.07, 1.36)</td>
<td>1.30 (1.18, 1.43)</td>
<td>1.78 (1.55, 2.04)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Adjusted model</td>
<td>1.00 (ref)</td>
<td>1.21 (1.07, 1.37)</td>
<td>1.26 (1.13, 1.42)</td>
<td>1.58 (1.35, 1.84)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Adjusted model+EI</td>
<td>1.00 (ref)</td>
<td>1.21 (1.07, 1.37)</td>
<td>1.27 (1.12, 1.43)</td>
<td>1.59 (1.35, 1.88)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Adjusted model+EI+BMI</td>
<td>1.00 (ref)</td>
<td>1.17 (0.97, 1.42)</td>
<td>1.11 (0.98, 1.26)</td>
<td>1.21 (1.05, 1.41)</td>
<td>0.0005</td>
</tr>
<tr>
<td>Sugar-sweetened soft drinks* (median intake, g/day)</td>
<td>(0.0)</td>
<td>(19.3)</td>
<td>(94.3)</td>
<td>(425.7)</td>
<td></td>
</tr>
<tr>
<td>No. cases</td>
<td>3,948</td>
<td>964</td>
<td>1,599</td>
<td>605</td>
<td></td>
</tr>
<tr>
<td>Crude model</td>
<td>1.00 (ref)</td>
<td>1.14 (0.97, 1.35)</td>
<td>1.16 (1.05, 1.28)</td>
<td>1.68 (1.40, 2.02)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Adjusted model</td>
<td>1.00 (ref)</td>
<td>1.13 (0.97, 1.31)</td>
<td>1.04 (0.94, 1.15)</td>
<td>1.39 (1.16, 1.67)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Adjusted model+EI</td>
<td>1.00 (ref)</td>
<td>1.12 (0.96, 1.31)</td>
<td>1.04 (0.94, 1.15)</td>
<td>1.39 (1.15, 1.69)</td>
<td>0.0001</td>
</tr>
<tr>
<td>Adjusted model+EI+BMI</td>
<td>1.00 (ref)</td>
<td>1.19 (0.91, 1.56)</td>
<td>1.07 (0.94, 1.21)</td>
<td><strong>1.29 (1.02, 1.63)</strong></td>
<td><strong>0.013</strong></td>
</tr>
</tbody>
</table>

*Adjusted model+EI+BMI

Romaguera-Bosch et al. Diabetologia 56:1520, 2013
## Associations between consumption of sugar sweetened beverages and fruit juice and incident type 2 diabetes: meta-analysis of prospective cohort studies

<table>
<thead>
<tr>
<th>Sugar Sweetened Beverages (n=17)</th>
<th>Not Adjusted for Adiposity: Relative Risk</th>
<th>$I^2$</th>
<th>Adjusted for Adiposity: Relative Risk</th>
<th>$I^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meta-analysis, crude:</td>
<td>1.25 (1.14 to 1.37)</td>
<td>89</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>+multivariable adjusted</td>
<td>1.18 (1.09 to 1.28)</td>
<td>89</td>
<td>1.13 (1.06 to 1.21)</td>
<td>79</td>
</tr>
<tr>
<td>+calibration for information bias</td>
<td>1.43 (1.20 to 1.70)</td>
<td>86</td>
<td>1.28 (1.12 to 1.46)</td>
<td>73</td>
</tr>
<tr>
<td>+calibration for publication bias</td>
<td>1.42 (1.19 to 1.69)</td>
<td>85</td>
<td>1.27 (1.10 to 1.46)</td>
<td>73</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fruit Juices (n=13)</th>
<th>Not Adjusted for Adiposity: Relative Risk</th>
<th>$I^2$</th>
<th>Adjusted for Adiposity: Relative Risk</th>
<th>$I^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meta-analysis, crude:</td>
<td>0.97 (0.90 to 1.06)</td>
<td>79</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>+multivariable adjusted</td>
<td>1.05 (0.99 to 1.11)</td>
<td>58</td>
<td>1.07 (1.01 to 1.14)</td>
<td>51</td>
</tr>
<tr>
<td>+calibration for information bias</td>
<td>1.06 (0.98 to 1.14)</td>
<td>49</td>
<td>1.10 (1.01 to 1.20)</td>
<td>29</td>
</tr>
<tr>
<td>+calibration for publication bias</td>
<td>Not detected</td>
<td>—</td>
<td>Not detected</td>
<td>—</td>
</tr>
</tbody>
</table>

Imamura et al. BMJ 351:h3576, 2015, dx.doi.org/10.1136/bmj.h3576 (epub 21 July 2015)
### Added Sugar Quintiles

<table>
<thead>
<tr>
<th>Quintile</th>
<th>Mean Sugar (g/day)</th>
<th>Prevalence Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>30g</td>
<td></td>
</tr>
<tr>
<td>2nd</td>
<td>58g</td>
<td>2.4</td>
</tr>
<tr>
<td>3rd</td>
<td>82g</td>
<td>5.3*</td>
</tr>
<tr>
<td>4th</td>
<td>113g</td>
<td>9.9*¥</td>
</tr>
<tr>
<td>5th</td>
<td>186g</td>
<td>8.7*</td>
</tr>
</tbody>
</table>

* Adjusted for age, BMI z-score, energy intake, and physical activity

* Statistically significant compared to 1st quintile (p < 0.05)

¥ Statistically significant compared to 2nd quintile (Wald test, p < 0.05)

Rodriguez et al., Public Health Nutr 2016 doi:10.1017/S1368980016000057
An international econometric analysis of diet and diabetes

Only changes in sugar availability correlated with changes in diabetes prevalence

Every extra 150 calories increased diabetes prevalence by 0.1%

But if those 150 calories were a can of soda, diabetes prevalence increased 11-fold, by 1.1%; p <0.001

These data meet the criteria for Causal Medical Inference (Bradford Hill):
   — dose
   — directionality
   — duration
   — precedence

Controlled for many confounders; obesity exacerbated, but did not confound the effect

These data estimate that 25% of diabetes worldwide is explained by sugar

Sugar is toxic unrelated to calories or weight

Isocaloric Fructose Restriction and Metabolic Improvement in Children with Obesity and Metabolic Syndrome

Robert H. Lustig, Kathleen Mulligan, Susan M. Noworolski, Viva W. Tai, Michael J. Wen, Ayca Erkin-Cakmak, Alejandro Gugliucci, and Jean-Marc Schwarz

Lustig et al. Obesity epub Oct 27, 2015
Strategy

• Isocaloric fructose restriction x 9 days in children who are habitual sugar consumers

• No change in weight

• Substitute complex carbs for sugar

• Maintain baseline macronutrient composition of the diet

• Study in PCRC at Day 0 and Day 10

• Assess changes in organ fat, *de novo* lipogenesis, and metabolic health
### Fasting Labs

<table>
<thead>
<tr>
<th></th>
<th>Day 0</th>
<th>Day 10</th>
<th>β-coefficient (Adjusted Change) [95% CI]</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate (bpm)</td>
<td>83.1 ± 10.7</td>
<td>80.1 ± 11.3</td>
<td>-2.8 [-6.5, +0.9]</td>
<td>0.13</td>
</tr>
<tr>
<td>Systolic BP (mmHg)</td>
<td>122.6 ± 10.5</td>
<td>121.1 ± 9.9</td>
<td>-1.39 [-4.9, +2.1]</td>
<td>0.43</td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>68.8 ± 8.9</td>
<td>63.7 ± 7.5</td>
<td>-4.9 [-8.1, -1.8]</td>
<td>0.003</td>
</tr>
<tr>
<td>Fasting lactate (mmol/L)</td>
<td>1.2 ± 0.4</td>
<td>0.9 ± 0.3</td>
<td>-0.3 [-0.5, -0.2]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Lactate AUC (mM/120 min)</td>
<td>160.0 ± 34.5</td>
<td>129.0 ± 34.5</td>
<td>-31.2 [-41.9, -20.5]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>HOMA-IR</td>
<td>7.9 ± 4.8</td>
<td>5.2 ± 2.6</td>
<td>-2.7 [-3.8, -1.5]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>AST (U/L) *</td>
<td>27.4 ± 14.1</td>
<td>23.8 ± 8.9</td>
<td></td>
<td>0.02</td>
</tr>
<tr>
<td>ALT (U/L)</td>
<td>28.9 ± 22.8</td>
<td>26.7 ± 19.6</td>
<td>-2.2 [-4.7, +0.3]</td>
<td>0.09</td>
</tr>
<tr>
<td>Fasting TG (mM)</td>
<td>1.4 ± 0.9</td>
<td>1.0 ± 0.5</td>
<td>-0.4 [-0.6, -0.2]</td>
<td>0.002</td>
</tr>
<tr>
<td>Fasting LDL-C (mM)</td>
<td>2.4 ± 0.6</td>
<td>2.1 ± 0.6</td>
<td>-0.3 [-0.4, -0.1]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fasting HDL-C (mM)</td>
<td>1.2 ± 0.2</td>
<td>1.0 ± 0.2</td>
<td>-0.1 [-0.2, -0.1]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fasting FFA (mM)</td>
<td>0.6 ± 0.2</td>
<td>0.7 ± 0.2</td>
<td>+0.1 [+0.1, +0.2]</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Oral glucose tolerance test before and after isocaloric fructose restriction

Lustig et al. Obesity (in press)
DNL is the Conversion of Dietary Carbohydrates into Lipids

Sugar → Fructose

\[ \text{Fructose} \rightarrow \text{Acetate} \rightarrow \text{Palmitate} \]

\[ \text{H}_3\text{C}^{13}\text{C}^\text{ONa} \]

Fat (lipids)

New Tracer Method using MIDA: Hellerstein and Neese, AJP 1999
DNL AUC Pre and Post Fructose Restriction

Endocrine Society, March 5, 2015
Changes in liver, visceral, and subcutaneous fat (n = 37)
Subanalysis of those with Grade I-III
(5% or greater)
hepatic steatosis on MRS (n = 22):
Changes in liver fat and CISI (n = 22)

Change in liver fat fraction 19.8%

Change in CISI 50.5%
Correlation between change in CISI vs. change in ectopic (liver, visceral) fat: multivariate linear regression analysis (Spearman R)

<table>
<thead>
<tr>
<th></th>
<th>Day 0</th>
<th>Day 10</th>
<th>Change in Fat (Absolute)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Liver Fat Fraction</td>
<td>Visceral Fat</td>
<td>Liver Fat Fraction</td>
</tr>
<tr>
<td>CISI Day 0</td>
<td>-0.33</td>
<td>-0.29</td>
<td></td>
</tr>
<tr>
<td>CISI Day 10</td>
<td></td>
<td>-0.33</td>
<td>-0.17</td>
</tr>
<tr>
<td>Change in CISI</td>
<td></td>
<td></td>
<td>-0.54* 0.06</td>
</tr>
</tbody>
</table>
Correlation between change in CISI vs. change in ectopic fat

Liver (n = 37)

Visceral (n = 37)

Liver (n = 22)

Visceral (n = 22)
Sugar and disease

• Causation
  – Diabetes
  – Heart Disease
  – Fatty Liver Disease
  – Tooth Decay

• Correlation
  – Cancer
  – Dementia
Environment
Environmental impacts

Sugar cultivation and processing impacts on biodiversity and ecosystem services at the field, farm and wider landscape levels.

Field level impacts

An estimated 5-6 million hectares of cropland is lost annually due to severe soil erosion and degradation. Soil is a living, dynamic resource, made up of different sized mineral particles (sand, silt and clay), organic matter and a diverse community of living organisms. Different soil types display different properties, including vulnerability to erosion, salinisation, acidity and alkalinity. Cultivation of sugar crops can contribute to soil degradation impacting on soil quantity (by increased rates of erosion and soil removal at harvest) and soil quality.

Water-generated soil erosion
Where irrigation application is inefficient or rainfall is high, water withdrawal is generally coupled with the loss of valuable soil from the farm. Worldwide estimates of soil losses to water erosion under sugar cane range from around 15 to over 5000/ha/yr.

Wind-generated soil erosion
Beet fields in particular are vulnerable to wind erosion as well as water erosion, since they are often left bare over winter.

Soil loss at harvest
Soil losses during harvesting, particularly of beet, are cause for concern; 10-30 percent of the total beet harvest weight is soil (tare) (3-5 percent with cane).

Estimates of soil losses from wind-generated erosion under sugar beet range from 13 to 49 tons/acre/year in the USA.

Three million tonnes of soil is lost per year from beet farms in the EU and 1.2 million tonnes per year in Turkey alone. It is estimated to cost the European the industry £40 million to separate the soil from the crop.

Everglades Agricultural Area (EAA)
Land Ownership 2014
Sugar holdings in orange, yellow, light green

Lake Okeechobee
Water Conservation Areas

Public Lands
FLORIDA CRYSTALS - OKEELANTA AND AFFILIATES
US SUGAR AND AFFILIATES - Acquired since 2010
US SUGAR AND AFFILIATES - Owned since 2010
KING RANCH INC
STAR RANCH & STAR FARMS

WEDGWORTH FARMS INC
SUGAR CANE GROWERS COOPERATIVE
HAND HOMER J
TRUCANE SUGAR CORP
Private Land Owners: <5,000 acres
State leased Lands

0 1 2 3 4 6 Miles
**THE RISE OF SUPERWEEDS**

Weed species often become resistant to herbicides. Glyphosate resistance, once deemed unlikely, rose after genetically engineered crops were introduced in the mid-1990s.

![Graph showing the rise of superweeds](image)

- **Herbicide class:**
  - Acetolactate synthase inhibitor (including imazethapyr)
  - Triazines (including atrazine)
  - Glyphosate
  - Ureas, amides
  - Dinitroanilines

- **Number of resistant species**
  - 125 species by 2000
  - 100 species by 1990
  - 75 species by 1980
  - 50 species by 1970
  - 25 species by 1960
  - 0 species by 1950

- **Timeline:**
  - 1950: 0 species
  - 1960: 25 species
  - 1970: 50 species
  - 1980: 75 species
  - 1990: 100 species
  - 2000: 125 species
  - 2010: Continued rise
Cash Flow
Cash Flow
Companies
How our food dollars have been reallocated

Breakdown Of Money Spent On Groceries

1982

- Meats (31.3%)
- Fruits & Vegetables (14.5%)
- Grains & Baked Goods (13.2%)
- Dairy Products (13.2%)
- Processed Foods & Sweets (11.6%)
- Beverages (11.0%)
- Other Foods 5.3%

2012

- Processed Foods & Sweets (22.9%)
- Meats (21.5%)
- Fruits & Vegetables (14.6%)
- Grains & Baked Goods (14.4%)
- Beverages (11.1%)
- Dairy Products (10.6%)
- Other Foods 5.1%

Philpott, Mother Jones 2012 (from Bureau of Labor Statistics)
Despite the economic downturn of 2008, McDonald’s revenues and stock price continued to rise between 2007-2011, and Coke and Pepsi still fared better than the S&P 500.
Stock prices of processed food companies compared to the S&P500, 2007-2011
The word on Wall Street is out:
In the last two years, Big Sugar has taken a beating
And soft drink manufacturers are now experiencing a drought

<table>
<thead>
<tr>
<th>Open</th>
<th>Close</th>
<th>SPC 1904.01</th>
<th>KO 43.29</th>
<th>DPS 64.88</th>
<th>MCD 91.59</th>
<th>PEP 93.55</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>~1904.01</td>
<td>KO 43.29</td>
<td>DPS 64.88</td>
<td>MCD 91.59</td>
<td>PEP 93.55</td>
</tr>
</tbody>
</table>

Dr. Pepper/ Snapple

S&P 500

Pepsi

Coke

McD
Cash Flow
Consumers
The price of food (per 1000 kcal) UK 2002-2012

Percent of Gross National Product spent on food, by country

Time Magazine, Feb 28, 2011
The money is not going to hospitals, physicians, or Big Pharma
It’s going to chronic metabolic disease

Insurance costs $2751 more annually per employee
Cash Flow Society
US Sugar Consumption, 1822-2005
versus US health care spending (% GDP)

- Growth of Sugar Industry
- Stabilization
- WWII
- HFCS + Sugar for Fat

PROCESSED FOOD

U.S. Commerce Service 1822-1910, combined with Economic Research Service, USDA 1910-2010
http://ushealthcarespending.gov
US Sugar Consumption, 1822-2005
versus US health care spending (% GDP)

PROCESSED FOOD

Stabilization
HFC + Sugar for Fat

Growth of Sugar Industry

U.S. Commerce Service 1822-1910, combined with Economic Research Service, USDA 1910-2010
http://ushealthcarespending.gov
Societal Math

• The food industry grosses $1 trillion/yr
  — $450 billion is gross profit

• Health care costs in the U.S. total $2.7 trillion/yr
  — 75% of which is chronic metabolic disease
  — 75% of which is preventable

• Thus, $1.4 trillion/yr is wasted

• We lose triple what the food industry makes

• This is unsustainable, and explains why Medicare is going broke
Diabetes experts tell G20 to tax sugar to save lives and money

BY BEN HIRSCHLER

Health | Wed Nov 11, 2015 7:08pm EST

Diabetes experts called on world leaders on Thursday to use sugar taxes to fight obesity, arguing such a move would save lives and slash healthcare budgets.

Ahead of a meeting of G20 leaders this weekend, the International Diabetes Federation (IDF) wants the dual epidemics of obesity and diabetes to be placed on the global agenda alongside major geopolitical and financial issues.
We believe higher taxation on “sugary” food and drinks would be the best option to reduce sugar intake and help fund the fast-growing healthcare costs associated with diabetes type II and obesity.
Budget 2016

George Osborne unveils sugar tax in eighth budget as growth forecast falls

- Proceeds of levy on soft drinks to fund school sports
- Cuts to business rates, capital gains and corporation tax
- Income tax personal allowance increased
- Growth forecast down from 2.4% to 2%

Katie Allen, Anushka Asthana and Rowena Mason

Wednesday 16 March 2016 10.58 EDT

Osborne announces soft drinks sugar tax and tax-free personal allowance – budget highlights video

George Osborne has unveiled a new tax on sugary drinks, such as Coca-Cola, Red Bull and Irn Bru, pledging to use the takings to provide more sports funding for schools.
The obesity and diabetes epidemic poses threat to future economic growth

The chart shows real GDP growth in the OECD area under simulations which adjust long-term OECD forecasts for different productivity levels of normal-weight, obese and diabetic individuals, and assume different levels of sugar consumption per capita in the high- and low-sugar scenarios.

Source: Morgan Stanley Research

ADDED SUGARS. Mars supports the DGAC’s recommendation that consumers reduce their added sugars intake to no more than 10% of daily energy intake. Further, Mars supports labeling and educational approaches, including added sugars labeling and off-label nutrition education…. At Mars, we believe it is time for all stakeholders – including industry – to engage in a constructive discussion that focuses on effective approaches to helping consumers manage their intake of added sugars.
Imagine the last 50 years was an experiment

The food industry posed the hypothesis:

**Processed food is better than real food.**

Outcomes:

- Consumption
- Health/Disease
- Environment
- Cash flow
  - companies
  - consumers
  - society
Imagine the last 50 years was an experiment

The food industry posed the hypothesis:

**Processed food is better than real food.**

Outcomes:

- Consumption ✔✔
- Health/Disease
- Environment
- Cash flow
  - companies
  - consumers
  - society
Imagine the last 50 years was an experiment

The food industry posed the hypothesis:

**Processed food is better than real food.**

Outcomes:

- Consumption ✔✔
- Health/Disease XXX (Death)
- Environment
- Cash flow
  - companies
  - consumers
  - society
Imagine the last 50 years was an experiment

The food industry posed the hypothesis:

**Processed food is better than real food.**

Outcomes:

- Consumption ✔✔
- Health/Disease XXX (Death)
- Environment X
- Cash flow
  - companies
  - consumers
  - society
Imagine the last 50 years was an experiment

The food industry posed the hypothesis:

**Processed food is better than real food.**

Outcomes:

- Consumption ✔✔
- Health/Disease XXX (Death)
- Environment X
- Cash flow
  - companies ✔✔ previously, X recently
  - consumers
  - society
Imagine the last 50 years was an experiment

The food industry posed the hypothesis:

**Processed food is better than real food.**

**Outcomes:**

- Consumption ✔✔
- Health/Disease XXX (Death)
- Environment X
- Cash flow
  - companies ✔✔ previously, X recently
  - consumers ✔ short-term, X long-term
  - society
Imagine the last 50 years was an experiment

The food industry posed the hypothesis:

**Processed food is better than real food.**

Outcomes:

- Consumption ✔✔
- Health/Disease XXX (Death)
- Environment X
- Cash flow
  - companies ✔✔ previously, X recently
  - consumers ✔ short-term, X long-term
  - society XXX
Only one answer:

REAL FOOD
Proposal #1

UCSF Healthy Beverage Initiative

UCSF Launches Healthy Beverage Initiative
Health Sciences Campus Will Focus Sales on Zero-Calorie and Nutritious Drinks

By Kristen Boie on May 29, 2015 | Email | Print

Most-Read News
E-Cigarettes Expose People to More Than “Harmless” Water Vapor
Kids with Autism, Sensory Processing Disorders Show Brain Wiring Differences
$100M Gift to Advance Health Sciences
Opening Day at the New Medical Center

Related News »
UCSF to Launch Redesign of Flagship Website
June 04, 2015
Swedish Medical Center Cuts Fruit Juice From Kids Menu

By RUBY DE LUNA  -  DEC 11, 2015
Proposal #2

Type 2 Diabetes should be renamed:

PROCESSED FOOD DISEASE
Proposal #3

Rollback the subsidies for processed food:

CORN
WHEAT
SOY
SUGAR
## Farm Subsidies and Obesity in the United States

*Julian M. Alston, Daniel A. Sumner, and Stephen A. Vosti*

### Table 1. Consequences in 2016 of a Complete Elimination of U.S. Commodity Protection and Subsidy Policies

<table>
<thead>
<tr>
<th></th>
<th>Production</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybeans</td>
<td>-2.86</td>
<td>-1.14</td>
</tr>
<tr>
<td>Wheat</td>
<td>-7.58</td>
<td>1.52</td>
</tr>
<tr>
<td>Maize (Corn)</td>
<td>-3.79</td>
<td>0.26</td>
</tr>
<tr>
<td>Rice</td>
<td>-11.71</td>
<td>-3.87</td>
</tr>
<tr>
<td>Cane and beet</td>
<td>-33.31</td>
<td>-15.30</td>
</tr>
<tr>
<td>Fruit and vegetables</td>
<td>4.42</td>
<td>-5.16</td>
</tr>
<tr>
<td>Beef cattle</td>
<td>1.44</td>
<td>-3.31</td>
</tr>
<tr>
<td>Pigs and poultry</td>
<td>0.41</td>
<td>-0.01</td>
</tr>
<tr>
<td>Milk</td>
<td>-0.45</td>
<td>-0.01</td>
</tr>
</tbody>
</table>

Source: See Alston, Table 3, which was based on a table provided by Vernon Topp, ABARE, December 2006, personal communication. Effects refer to elimination of U.S. farm programs as represented in ABARE (2006) Research Report 06-10, Scenario 1.
Proposal #5

Remove Sugar from the FDA “Generally Recognized as Safe” (GRAS) List
Hidden sugar is like a ticking time bomb.
Fed Up blows the lid off everything we thought we knew about food and weight loss, revealing a 30-year campaign by the food industry, aided by the U.S. government, to mislead and confuse the American public, resulting in one of the largest health epidemics in history.
Available on Vimeo on Demand
Public Television Special, USA
Now also in Spanish “Dulce Venganza”
We have started a non-profit to provide medical, nutritional and legal analysis and consultation to promote personal and public health vs. Big Food.

responsiblefoods.org