Dietary Patterns for Cardiometabolic Health: 
Unscrambling the Guidance

David L. Katz, MD, MPH, FACPM, FACP
Director, Prevention Research Center
Yale University
Key Points, Over Easy

- Modern Epidemiology: The Dark Wood
- The Short View: Eggs & Evolving Dietary Guidance
- The Long View: Eggs & Evolutionary Biology
- From Diatribe to Data: Eggs, Interventions, and Epidemiology
- The View at Home: Eggs & Endothelial Function
- The Forest Through the Trees: Repercussions Beyond Breakfast
- Concerns, In Context
- Eggspectations & Implications
Modern Epidemiology: The Dark Wood
There is **Lifestyle**... and everything else


The People in Potsdam


- **Or the UK:**

- **Or the US**
Nurturing Nature: The Leverage of Living Well

- A Decade Later, Genetic Map Yields Few New Cures
  - By Nicholas Wade
  - June 12, 2010

- The Cup of Life: Medical Science and Genomic Disappointments (D. Katz)


The Master Levers of Destiny

- Feet
- Forks

But....
Lost in Translation…

Knowledge, alas, isn’t power…

The Short View: Eggs & Evolving Dietary Guidance
Dietary Guidance - Then


- Emphasis on grains as the largest segment of the diet
- Avoidance of fats/oils, animal products

Summary: High carbohydrate, low fat diets are best
Dietary Guidance - Now

2010 MyPlate

- Less space devoted to Grains food group
- Greater emphasis on high-quality protein
  - Designating almost ¼ plate to Protein food group in addition to dairy
  - Protein is the only nutrient listed on the plate
Impact on the US Diet/Health

No change in heart disease risk…but an **increase in calorie consumption**

Accompanied by a decreased intake of: Zinc, calcium, copper, B-vitamins, fiber, and vitamin A

*Unintended consequences for nutrient quality and caloric density of American diets*

- **Decreases in:**
  - Red meat (25%)
  - Dairy (30%)
  - Eggs (40%)

- **Increases in:**
  - Grains (in place of vegetables)
  - Fruit juices (in place of whole fruits)
  - Soda
  - Snack foods (refined carbohydrates)
Impact on the US Diet

Decreased intake of

- **Total fat** (from 40% of calories to 33%)
- **Cholesterol** (from 650 mg/d to < 250 mg/d)
- **Saturated fat** (from 17% of calories to 12%)
Energy Sources for Americans (age 2+)

Top five:
1) Grain based desserts and snacks
2) Yeast breads
3) Chicken and chicken mixed dishes
4) Soda
5) Pizza

We Live Where Good Advice...

“Eat food, not too much, mostly plants.

- Michael Pollan

...can be hard to swallow

http://www.choosemyplate.gov/
Mostly Plants? *Fuggedaboudit!*...  


The Long View: Eggs & Evolutionary Biology
A dash of dietary Darwinism…


From Diatribe to Data: Eggs, Interventions, and Epidemiology
American Heart Association Dietary Guidelines

Dietary Cholesterol

The Association noted that dietary cholesterol – the cholesterol found in foods like eggs and shrimp – be limited to no more than 300 mg per day, and recommended that individuals eat no more than 3 egg yolks per week.

Scientific Basis:

- Animal Studies
- Epidemiological Surveys
- Clinical Investigation
Epidemiological Studies

Major Trials:

- Health Professionals Follow-up [n>43,000]
- Nurses’ Health Study [n=80,082]
- ATBC Cancer Prevention Study [n=21,930 men]

Conclusion:

Dietary cholesterol unrelated to CHD
Recent evidence suggests that dietary cholesterol has limited influence on serum cholesterol or cardiac risk.


- Biostatistical Fact Sheet: Risk factors; high blood cholesterol and other lipids

And Keeps Hatching...


Meal Patterns

Unbalanced Protein Distribution
- Breakfast: ~10 g protein
- Lunch: ~20 g protein
- Dinner: ~60 g protein

Balanced Protein Distribution
- Breakfast: ~30 g protein
- Lunch: ~30 g protein
- Dinner: ~30 g protein

Maximum Protein Synthesis
High Quality Protein Breakfast

Stacking Up the Protein Content of Popular Breakfasts

Not all breakfasts are created equal when it comes to protein. Examine the protein content of four popular American breakfast options that are all similar in calories. While each of these breakfasts provides a similar amount of calories, the amount and type of protein provided varies significantly.

1. **33 Grams of Protein**
   - 1 Whole Egg + 1 Egg White Canadian Bacon, 1 Low-fat Cheese, 1 ounce English Muffin, ¼ ounce Non-fat Milk, 1 cup
   - 340 Calories

2. **13 Grams of Protein**
   - Ready-To-Eat Whole-Grain Cereal, 1 cup Non-fat Milk, 1/2 cup Banana, 1 small Orange Juice, 1/2 cup
   - 330 Calories

3. **12 Grams of Protein**
   - Pancakes, 2 Maple Syrup, 1 Tablespoon Strawberries, ¼ cup Non-fat Milk, 1 cup
   - 325 Calories

4. **3 Grams of Protein**
   - Glazed Doughnut Coffee, 1 cup Cream, 1 Tablespoon Sugar, 1 Teaspoon
   - 295 Calories
High-Risk Populations

- Metabolic Syndrome
- Cardiovascular Disease
Metabolic Syndrome

Whole Eggs Improved Blood Lipids

Methods:

- Participants with metabolic syndrome consumed either 3 whole eggs/day (n=20) or the equivalent amount of yolk-free egg substitute (n=17) as part of a moderately carbohydrate-restricted diet (25%–30% energy) for 12 weeks
- Note: cholesterol intake doubled (from 360 mg/dL pre study to 740 mg/dL post study) in the 3 egg/day group

Results:

- Improvements in plasma triglycerides, oxidized LDL, small, dense LDL

Conclusion: Daily whole egg consumption in conjunction with a moderately carb-restricted diet leads to improvements in the atherogenic lipoprotein pattern exhibited in individuals with metabolic syndrome
The View at Home: Eggs & Endothelial Function
Endothelial Function

- The mother of all cardiac risk measures
Anatomy of Artery

- **Artery**
- **Tunica intima**: endothelium that lines the lumen of all vessels
- **Tunica media**: smooth muscle cells and elastic fibers
- **Tunica adventitia**: collagen fibers

[Diagram of an artery showing its layers and the labels mentioned above.]
Schematic drawing of ultrasound imaging of the brachial artery with **upper** versus **lower cuff** placement and transducer position above the antecubital fossa.
Brachial Artery Reactivity Study
Ultrasound Image of the Brachial Artery
Brachial Artery Reactivity Study

(A) Ultrasound image of the brachial artery at baseline

(B) 1 min after hyperemic stimulus.
Objectives

- To determine the effects of eggs ingestion on endothelial function, a reliable index of cardiovascular risk.

- To determine the effects of eggs ingestion on BMI, Lipid Panel, and Blood Pressure.
Methods

Sample

50 Healthy Adults [men (n=31) and women (N=31)]

Inclusion Criteria

✓ Age greater than 35 for male
✓ Post menopausal and not currently using HRT for females
✓ Non-smokers
✓ No known coronary artery or other vascular disease
✓ No vasoactive medication use
✓ No regular use of high dose vitamin E or fiber supplements.
✓ Subjects from all ethnic and minority groups equally eligible
Results

- Flow Mediated Dilatation (FMD) after an acute treatment with egg, oatmeal, or sausage and cheese.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Pre-prandial*</th>
<th>Post-prandial*</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg</td>
<td>13.7 ± 11.0</td>
<td>9.6 ± 11.5† ‡</td>
<td>-4.04†</td>
</tr>
<tr>
<td>Oatmeal</td>
<td>8.3 ± 13.0</td>
<td>8.4 ± 10.3† ‡</td>
<td>-0.14†</td>
</tr>
<tr>
<td>Sausage and cheese</td>
<td>10.9 ± 7.6</td>
<td>10.4 ± 9.9† ‡</td>
<td>-0.50†</td>
</tr>
</tbody>
</table>

*Mean ± S.D.
† p Value >0.05 adjusting with pre-prandial (paired t test).
‡ p Value >0.05 compared to other treatments (ANOVA).
## Results

**Outcomes Variables after 6 weeks of treatment with egg or oatmeal**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Pre-prandial*</th>
<th>Post-prandial*</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Egg</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reference diameter (cm)</td>
<td>0.43 ± 0.08</td>
<td>0.43 ± 0.08</td>
<td>–</td>
</tr>
<tr>
<td>Hyperemic diameter, at 60 s (cm)</td>
<td>0.47 ± 0.08</td>
<td>0.44 ± 0.07</td>
<td>–</td>
</tr>
<tr>
<td>Flow-mediated vasodilation (FMD)</td>
<td>8.66 ± 9.69</td>
<td>8.32 ± 6.33†‡</td>
<td>−0.96‡</td>
</tr>
<tr>
<td><strong>Oatmeal</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reference diameter (cm)</td>
<td>0.43 ± 0.07</td>
<td>0.43 ± 0.07</td>
<td>–</td>
</tr>
<tr>
<td>Hyperemic diameter, at 60 s (cm)</td>
<td>0.46 ± 0.08</td>
<td>0.47 ± 0.07</td>
<td>–</td>
</tr>
<tr>
<td>Flow-mediated vasodilation (FMD)</td>
<td>6.98 ± 8.45</td>
<td>6.56 ± 7.99†‡</td>
<td>−0.79‡</td>
</tr>
</tbody>
</table>

*Mean ± S.D.

† _p_ Value >0.05 adjusting with pre-prandial (paired t test).

‡ _p_ Value >0.05 compared to different treatments (ANOVA).
## Results

- Outcome variables after 6 weeks of treatment with egg or oatmeal

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean ± S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>28.7 ± 7.2</td>
</tr>
<tr>
<td>Total cholesterol (mg/dl)</td>
<td>203.8 ± 31.5</td>
</tr>
<tr>
<td>HDL (mg/dl)</td>
<td>52.6 ± 14.6</td>
</tr>
<tr>
<td>LDL (mg/dl)</td>
<td>124.8 ± 25.0</td>
</tr>
<tr>
<td>Triglycerides (mg/dl)</td>
<td>135.6 ± 77.3</td>
</tr>
<tr>
<td>Reference diameter (cm)</td>
<td>0.37 ± 0.07</td>
</tr>
<tr>
<td>Diameter change 60 s to baseline (cm)</td>
<td>0.04 ± 0.04</td>
</tr>
<tr>
<td>% Diameter change 60 s to baseline</td>
<td>11.0 ± 9.5</td>
</tr>
<tr>
<td>Systolic blood pressure (mm Hg)</td>
<td>129.8 ± 11.7</td>
</tr>
<tr>
<td>Diastolic blood pressure (mm Hg)</td>
<td>79.4 ± 9.1</td>
</tr>
</tbody>
</table>

* $p$ Value < 0.05 compared to baseline value.
Study 1 Takeaway

- 2 eggs a day did not adversely affect endothelial function
- 2 eggs a day did not alter serum cholesterol
Methods

- Population: 40 Adults
- 16 men and 16 women diagnosed with Hiperlipidemia
- Eligibility criteria:
  - Male age > 35 years old
  - Postmenopausal women not currently use HRT.
  - Non smokers, Hyperlipidemic (tot Chol > 240; and/or LDL > 160; tot Cholesterol ratio > 5.7)
  - All ethnic and minority group were equally eligible
Outcome Measures

- Endothelial function assessment
- Lipid profile
- Body weight
- Blood pressure
Results

Sustained phase: Mean Change after six weeks of treatment

<table>
<thead>
<tr>
<th>Variable</th>
<th>Egg (n = 36)</th>
<th>Egg substitute (n = 36)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Endothelial Function</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow Mediated Dilatation (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>5.6 ± 3.9</td>
<td>5.8 ± 3.9</td>
<td>0.78</td>
</tr>
<tr>
<td>6 Weeks</td>
<td>5.3 ± 4.1</td>
<td>6.9 ± 4.0</td>
<td></td>
</tr>
<tr>
<td>Change</td>
<td>-0.1 ± 1.5 (P = 0.80)</td>
<td>1.0 ± 1.2 (P &lt; 0.01)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Adjusted change†</td>
<td>-0.2 ± 1.3 (P = 0.35)</td>
<td>0.9 ± 1.4 (P &lt; 0.01)</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Stimulus adjusted response measure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>0.08 ± 0.10</td>
<td>0.06 ± 0.06</td>
<td>0.39</td>
</tr>
<tr>
<td>6 Weeks</td>
<td>0.08 ± 0.11</td>
<td>0.09 ± 0.09</td>
<td></td>
</tr>
<tr>
<td>Change</td>
<td>0.01 ± 0.05 (P = 0.54)</td>
<td>0.03 ± 0.06 (P &lt; 0.01)</td>
<td>0.07</td>
</tr>
</tbody>
</table>

Values are mean ± SD; p-value obtained from ANOVA for repeated measurements except otherwise stated; p-values in parenthesis indicate within-group p-values; *p-value obtain from student t test; Change = 6 Weeks - Baseline; † obtained from generalized linear models, controlling for age, blood pressure, LDL and BMI.
# Results

Sustained phase: Mean Change after six weeks of treatment

## Lipid Panel

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>6 Weeks</th>
<th>Change</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Cholesterol</strong> (mg/dL)</td>
<td>244 ± 24</td>
<td>239 ± 27</td>
<td>-5 ± 21 (P = 0.10)</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td><strong>Low Density Lipoprotein</strong> (mg/dL)</td>
<td>168 ± 17</td>
<td>165 ± 24</td>
<td>-2 ± 19 (P = 0.30)</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>High Density Lipoprotein</strong> (mg/dL)</td>
<td>52 ± 15</td>
<td>51 ± 14</td>
<td>-1 ± 11 (P = 0.53)</td>
<td>0.63</td>
</tr>
<tr>
<td><strong>Triglycerides</strong> (mg/dL)</td>
<td>132 ± 52</td>
<td>118 ± 47</td>
<td>-14 ± 37 (P = 0.02)</td>
<td>0.83</td>
</tr>
<tr>
<td><strong>Total Cholesterol to High Density Lipoprotein Ratio</strong></td>
<td>5.0 ± 1.3</td>
<td>5.0 ± 1.3</td>
<td>-0.06 ± 0.66 (P = 0.54)</td>
<td>0.38</td>
</tr>
</tbody>
</table>

## Body Composition

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>6 Weeks</th>
<th>Change</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weight (kg)</strong></td>
<td>81 ± 19</td>
<td>82 ± 18</td>
<td>0.4 ± 2.3 (P = 0.33)</td>
<td>0.52</td>
</tr>
<tr>
<td><strong>Body Mass Index (kg/m²)</strong></td>
<td>29.2 ± 4.5</td>
<td>29.3 ± 4.3</td>
<td>0.2 ± 0.8 (P = 0.13)</td>
<td>0.56</td>
</tr>
</tbody>
</table>

*Values are mean ± SD; p-value obtained from ANOVA for repeated measurements except otherwise stated; p-values in parenthesis indicate within-group p-values; *p-value obtained from student t-test; Change = 6 Weeks - Baseline; † obtained from generalized linear models, controlling for age, blood pressure, LDL and BMI*
Study 2 Takeaway:

- ...ditto, in adults with hyperlipidemia
Effects of Egg Ingestion on Endothelial Function in Adults with Coronary Artery Disease: A Randomized, Controlled, Crossover Trial

David L. Katz, MD, MPH
Joseph Gnanaraj, MD
Judith A. Treu, MS, RD
Yingying Ma, MD, RVT
Yasemin Kavak, BS
Valentine Y. Njike, MD, MPH

Yale University Prevention Research Center
Objectives

- To determine the effects of daily consumption of eggs or egg substitute for 6 weeks on endothelial function, measured as flow-mediated dilatation in participants with clinically established coronary artery disease (CAD)
  - Hypothesis: To show that daily consumption of eggs or egg substitute, as compared to a typical high-carbohydrate American breakfast, will have neutral or superior effects on endothelial function in participants with CAD

- To assess the effects of daily consumption of eggs, egg substitute and high-carbohydrate American breakfast for a 6-week period on cholesterol and lipoprotein levels in participants with CAD
  - Hypothesis: To show equivalency or superior effects after consumption of eggs or egg substitute as compared to a typical high-carbohydrate American breakfast on lipid panel
Study Design

- Randomized, controlled single-blind crossover trial

- 3 treatment assignments of daily ingestion for 6 weeks each:
  - Eggs: Two eggs
  - Egg substitute: $\frac{1}{2}$ cup of Egg Beaters
  - High-carbohydrate breakfast: Bagel, waffles, pancakes, or cereal and milk
## Nutrient Profile of the Selected Options for a High-Carbohydrate Breakfast

<table>
<thead>
<tr>
<th>Food product</th>
<th>Serving size</th>
<th>Kcal</th>
<th>Total Carbs (g)</th>
<th>Sugars (g)</th>
<th>Fiber (g)</th>
<th>Fat (g)</th>
<th>Protein (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bagel, Lender’s original style, plain, frozen</td>
<td>1 bagel (57 g)</td>
<td>140</td>
<td>29</td>
<td>2</td>
<td>1</td>
<td>0.5</td>
<td>5</td>
</tr>
<tr>
<td>Waffles, Kellogg’s Special K, original</td>
<td>2 waffles (70 g)</td>
<td>160</td>
<td>29</td>
<td>2</td>
<td>&lt; 1</td>
<td>2.5</td>
<td>5</td>
</tr>
<tr>
<td>Pancakes, Aunt Jemima, low fat buttermilk</td>
<td>2 pancakes (69 g)</td>
<td>135</td>
<td>26</td>
<td>6</td>
<td>&lt; 1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Cereal &amp; skim milk (Chex)</td>
<td>1 C cereal + ½ C milk</td>
<td>156</td>
<td>32</td>
<td>9</td>
<td>1</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Chex, General Mills, cereal only</td>
<td>1 cup (31 g)</td>
<td>(114)</td>
<td>(26)</td>
<td>(3)</td>
<td>(1)</td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Milk, skim, ½ cup</td>
<td>½ cup (122 g)</td>
<td>(42)</td>
<td>(6)</td>
<td>(6)</td>
<td>(0)</td>
<td>(0)</td>
<td>(4)</td>
</tr>
<tr>
<td>Cereal &amp; skim milk (Corn Flakes)</td>
<td>1 C cereal + ½ C milk</td>
<td>143</td>
<td>30</td>
<td>9</td>
<td>1</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Corn Flakes, Kellogg, cereal only</td>
<td>1 cup (28 g)</td>
<td>(101)</td>
<td>(24)</td>
<td>(3)</td>
<td>(1)</td>
<td>(0)</td>
<td>(2)</td>
</tr>
<tr>
<td>Milk, skim, ½ cup</td>
<td>½ cup (122 g)</td>
<td>(42)</td>
<td>(6)</td>
<td>(6)</td>
<td>(0)</td>
<td>(0)</td>
<td>(4)</td>
</tr>
</tbody>
</table>
Randomization

Sequence Permutations for Treatment Assignments

<table>
<thead>
<tr>
<th>Treatment 1</th>
<th>Washout (4 weeks)</th>
<th>Treatment 2</th>
<th>Washout (4 weeks)</th>
<th>Treatment 3 (6 weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eggs</td>
<td></td>
<td>Eggs</td>
<td></td>
<td>Hi-Carb Breakfast</td>
</tr>
<tr>
<td>Eggs</td>
<td></td>
<td>Hi-Carb Breakfast</td>
<td></td>
<td>Egg Substitute</td>
</tr>
<tr>
<td>Egg Substitute</td>
<td></td>
<td>Eggs</td>
<td></td>
<td>Hi-Carb Breakfast</td>
</tr>
<tr>
<td>Egg Substitute</td>
<td></td>
<td>Hi-Carb Breakfast</td>
<td></td>
<td>Egg Substitute</td>
</tr>
<tr>
<td>Hi-Carb Breakfast</td>
<td></td>
<td>Eggs</td>
<td></td>
<td>Eggs</td>
</tr>
<tr>
<td>Hi-Carb Breakfast</td>
<td></td>
<td>Egg Substitute</td>
<td></td>
<td>Eggs</td>
</tr>
</tbody>
</table>

NOTE: “Hi-Carb Breakfast” refers to any of the following choices available to study participants during the high-carbohydrate breakfast treatment period: bagels, waffles, pancakes, or cereal & skim milk.
Figure 1: Flow of Participants through the Trial

- 277 Responded to Recruiting Advertisements
  - Excluded (n=243)
    - 227 Not meeting inclusion criteria
    - 16 Not eligible after clinical screening
    - 2 Eligible participants withdrew before the initiation of the study
  - Randomized (n=32)
    - Egg (n=11)
      - 4 week washout
        - Alternate treatment assignment (n=11)
        - 4 week washout
        - Final treatment assignment (n=11)
    - Egg Beaters (n=10)
      - 4 week washout
        - Alternate treatment assignment (n=10)
        - 4 week washout
        - Final treatment assignment (n=10)
    - High-Carbohydrate Breakfast (n=11)
      - 4 week washout
        - Alternate treatment assignment (n=11)
        - 4 week washout
        - Final treatment assignment (n=10)
    - 1 participant dropped out due to inability to comply with study protocol
    - 1 participant dropped out for medical reason unrelated to the study
- 30 Completed Trial
Study Population

- Inclusion Criteria:
  - Clinically established coronary artery disease (CAD):
    - Presence of at least one coronary artery stenosis >50%
  - Males: Age greater than 35
  - Females: Post-menopausal, not currently on hormone replacement therapy
  - Non-smokers
Study Population

Exclusion Criteria:

- Anticipated inability to complete the study protocol
- Current eating disorder
- Use of lipid-lowering or antihypertensive medications unless stable on medication for at least 3 months and willing to refrain from taking medication for 12 hours prior to endothelial function scanning
- Regular use of high doses of vitamin C or E
- Use of vasoactive medications (including glucocorticoids, antineoplastic agents, psychoactive agents, bronchodilators, or nutriceuticals)
- Regular use of fiber supplements
- Diabetes
- Sleep apnea
- Restricted diets by choice (e.g., vegetarian, vegan, etc.)
- Coagulopathy, known bleeding diathesis, history of clinically significant hemorrhage, and/or current use of warfarin
Subjects

- 32 subjects recruited from the Lower Naugatuck Valley, CT
  - 26 men
  - 6 women
- Mean age: 67.1 years

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>6 (18.8%)</td>
</tr>
<tr>
<td>Male</td>
<td>26 (81.2%)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>31 (96.9%)</td>
</tr>
<tr>
<td>Non-White</td>
<td>1 (3.1%)</td>
</tr>
<tr>
<td>Medication</td>
<td></td>
</tr>
<tr>
<td>Lipid-Lowering Medication Use</td>
<td>90.6%</td>
</tr>
<tr>
<td>Blood Pressure-Lowering Medication Use</td>
<td>87.5%</td>
</tr>
<tr>
<td>Aspirin use</td>
<td>78.1%</td>
</tr>
<tr>
<td>Age (years)</td>
<td>67.1 ± 7.3</td>
</tr>
<tr>
<td>Endothelial Function</td>
<td></td>
</tr>
<tr>
<td>Flow Mediated Dilatation (%)</td>
<td>6.3 ± 2.9</td>
</tr>
<tr>
<td>Stimulus Adjusted Response Measure</td>
<td>0.08 ± 0.06</td>
</tr>
<tr>
<td>Lipid Panel</td>
<td></td>
</tr>
<tr>
<td>Total Cholesterol (mg/dL)</td>
<td>153.0 ± 27.8</td>
</tr>
<tr>
<td>Triglyceride (mg/dL)</td>
<td>118.0 ± 43.2</td>
</tr>
<tr>
<td>High Density Lipoprotein Cholesterol (mg/dL)</td>
<td>54.5 ± 17.5</td>
</tr>
<tr>
<td>Low Density Lipoprotein Cholesterol (mg/dL)</td>
<td>75.3 ± 24.2</td>
</tr>
<tr>
<td>Total Cholesterol/ High Density Lipoprotein Cholesterol</td>
<td>3.0 ± 0.9</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td></td>
</tr>
<tr>
<td>Systolic (mmHg)</td>
<td>136.1 ± 15.5</td>
</tr>
<tr>
<td>Diastolic (mmHg)</td>
<td>76.7 ± 7.9</td>
</tr>
<tr>
<td>Anthropometric Measures</td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>92.8 ± 19.0</td>
</tr>
<tr>
<td>Body Mass Index (kg/m²)</td>
<td>31.2 ± 4.8</td>
</tr>
</tbody>
</table>

Table 2. Demographic Characteristics and Baseline Values (N=32)
Values are mean ± SD except otherwise stated
Outcome Measures

- **Primary:**
  - Endothelial function

- **Secondary:**
  - Serum lipids:
    - Total cholesterol
    - Triglycerides
    - High-density lipoprotein (HDL)
    - Low-density lipoprotein (LDL)
  - Blood pressure
  - Anthropometric measures:
    - Weight
    - BMI
Statistical Analysis

- FMD = \{\left[\frac{\text{response} - \text{baseline}}{\text{baseline}}\right] \times 100\}

- Sample size (n=32) was determined to:
  - Allow for 20% attrition
  - Provide at least 80% power
    - Detect a minimum difference of 3.5% in FMD between eggs and high-carbohydrate breakfast groups
    - Maximum allowable type I error for 3 pair-wise comparisons: 5%
Results

- Daily consumption of 2 eggs for 6 weeks showed no difference when compared to a high-carbohydrate breakfast ($p=0.33$)

- Total cholesterol, triglycerides, HDL, and LDL were unaffected by egg intake, and not adversely affected as compared to daily consumption of a high-carbohydrate breakfast

- Blood pressure, body weight, and BMI were unaffected by egg intake, and did not differ from the high-carbohydrate breakfast

- No differences in effects on endothelial function, lipid profile, blood pressure, or anthropometric measures ($p>0.05$) between eggs and egg substitute (Egg Beaters)
Table 2. Outcome Measures at 6 Weeks

<table>
<thead>
<tr>
<th>Variable</th>
<th>Egg</th>
<th>Egg Beaters</th>
<th>High Carbohydrate Breakfast</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Endothelial Function</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow Mediated Dilatation (%)</td>
<td>7.2 ± 2.9</td>
<td>7.3 ± 2.2*</td>
<td>7.5 ± 2.9*</td>
</tr>
<tr>
<td>Stimulus Adjusted Response Measure</td>
<td>0.1±0.0</td>
<td>0.1±0.1*</td>
<td>0.1±0.0</td>
</tr>
<tr>
<td><strong>Lipid Panel</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Cholesterol (mg/dL)</td>
<td>158.3 ± 28.6</td>
<td>153.4 ± 16.3</td>
<td>156.2 ± 27.4</td>
</tr>
<tr>
<td>Triglyceride (mg/dL)</td>
<td>110.2 ± 37.7</td>
<td>109.5 ± 44.3</td>
<td>106.2 ± 29.2</td>
</tr>
<tr>
<td>High Density Lipoprotein Cholesterol (mg/dL)</td>
<td>56.5 ± 18.1</td>
<td>54.3 ± 16.2</td>
<td>54.5 ± 16.6</td>
</tr>
<tr>
<td>Low Density Lipoprotein Cholesterol (mg/dL)</td>
<td>80.1 ± 26.6</td>
<td>77.5 ± 27.8</td>
<td>80.9 ± 25.6*</td>
</tr>
<tr>
<td>Total Cholesterol/ High Density Lipoprotein Cholesterol</td>
<td>3.0 ± 0.9</td>
<td>3.1 ± 1.0</td>
<td>3.1 ± 0.9</td>
</tr>
<tr>
<td><strong>Blood Pressure</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic (mmHg)</td>
<td>132.8 ± 14.1</td>
<td>135.4 ± 16.3</td>
<td>135.5 ± 14.9</td>
</tr>
<tr>
<td>Diastolic (mmHg)</td>
<td>77.2 ± 6.1</td>
<td>76.8 ± 8.5</td>
<td>76.7 ± 6.9</td>
</tr>
<tr>
<td><strong>Anthropometric Measures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>90.8 ± 17.5</td>
<td>91.8 ± 18.5</td>
<td>91.8 ± 17.1</td>
</tr>
<tr>
<td>Body Mass Index (kg/m²)</td>
<td>28.9 ± 8.9</td>
<td>30.1 ± 7.2</td>
<td>31.0 ± 4.3</td>
</tr>
</tbody>
</table>

*Significant change from baseline (p<0.05)
† significant compared to High Carbohydrate Breakfast (p<0.05)
‡ significant compared to Egg Beaters (p<0.05)
Table 3. Change in Outcome Measures from Baseline Values

<table>
<thead>
<tr>
<th>Variable</th>
<th>Egg</th>
<th>Egg Beaters</th>
<th>High Carbohydrate Breakfast</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Endothelial Function</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow Mediated Dilatation (%)</td>
<td>0.6 ± 1.2</td>
<td>0.9 ± 2.2*</td>
<td>1.1 ± 2.2*</td>
</tr>
<tr>
<td>Stimulus Adjusted Response Measure</td>
<td>0.0 ± 0.1</td>
<td>0.0 ± 0.0*</td>
<td>0.0 ± 0.1</td>
</tr>
<tr>
<td><strong>Lipid Panel</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Cholesterol (mg/dL)</td>
<td>6.3 ± 22.1</td>
<td>2.3 ± 14.2</td>
<td>3.2 ± 15.8</td>
</tr>
<tr>
<td>Triglyceride (mg/dL)</td>
<td>-8.8 ± 31.7</td>
<td>-9.3 ± 35.6</td>
<td>-11.8 ± 34.8</td>
</tr>
<tr>
<td>High Density Lipoprotein Cholesterol (mg/dL)</td>
<td>1.7 ± 6.7</td>
<td>0.1 ± 6.0</td>
<td>-0.03 ± 8.2</td>
</tr>
<tr>
<td>Low Density Lipoprotein Cholesterol (mg/dL)</td>
<td>6.3 ± 18.9</td>
<td>4.0 ± 13.6</td>
<td>5.7 ± 13.9*</td>
</tr>
<tr>
<td>Total Cholesterol/ High Density Lipoprotein Cholesterol</td>
<td>-0.04 ± 0.6</td>
<td>0.1 ± 0.5</td>
<td>0.05 ± 0.5</td>
</tr>
<tr>
<td><strong>Blood Pressure</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic (mmHg)</td>
<td>-3.4 ± 13.6</td>
<td>-0.7 ± 12.7</td>
<td>-1.2 ± 13.3</td>
</tr>
<tr>
<td>Diastolic (mmHg)</td>
<td>0.3 ± 7.6</td>
<td>0.1 ± 8.7</td>
<td>-0.1 ± 9.1</td>
</tr>
<tr>
<td><strong>Anthropometric Measures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>-1.1 ± 6.2</td>
<td>-0.7 ± 2.9</td>
<td>-0.9 ± 4.9</td>
</tr>
<tr>
<td>Body Mass Index (kg/m²)</td>
<td>-2.4 ± 8.1</td>
<td>-1.2 ± 5.7</td>
<td>-0.3 ± 1.6</td>
</tr>
</tbody>
</table>

*Significant change from baseline (p<0.05)
† significant compared to High Carbohydrate Breakfast (p<0.05)
‡ significant compared to Egg Beaters (p<0.05)
<table>
<thead>
<tr>
<th>Variable</th>
<th>Eggs</th>
<th>Egg Beaters</th>
<th>High Carbohydrate Breakfast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kcal)</td>
<td>2664.4 ± 2271.0</td>
<td>2333.0 ± 1359.1</td>
<td>2705.5 ± 2119.3</td>
</tr>
<tr>
<td>Fat (kcal)</td>
<td>1098.9 ± 1628.7</td>
<td>757.3 ± 508.5</td>
<td>792.4 ± 549.3</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>122.1 ± 181.0</td>
<td>84.2 ± 56.5</td>
<td>88.1 ± 61.1</td>
</tr>
<tr>
<td>% Kcal from Fat</td>
<td>36.6 ± 10.6†</td>
<td>32.2 ± 7.4</td>
<td>29.6 ± 9.4</td>
</tr>
<tr>
<td>Saturated fatty acids (kcal)</td>
<td>341.3 ± 488.2</td>
<td>224.1 ± 153.2</td>
<td>225.9 ± 125.9</td>
</tr>
<tr>
<td>% Kcal from Saturated fatty acids</td>
<td>11.9 ± 3.9††</td>
<td>9.7 ± 3.5</td>
<td>9.0 ± 3.1</td>
</tr>
<tr>
<td>Protein (g/day)</td>
<td>116.6 ± 120.9</td>
<td>97.3 ± 44.4</td>
<td>92.7 ± 36.6</td>
</tr>
<tr>
<td>% Kcal from Protein</td>
<td>17.9 ± 4.0</td>
<td>18.6 ± 6.5</td>
<td>15.8 ± 5.1††</td>
</tr>
<tr>
<td>Carbohydrates (g)</td>
<td>247.7 ± 121.2</td>
<td>253.4 ± 128.6</td>
<td>288.7 ± 110.1</td>
</tr>
<tr>
<td>% Kcal from Carbohydrates</td>
<td>42.3 ± 12.6††</td>
<td>45.0 ± 10.8</td>
<td>49.7 ± 13.2</td>
</tr>
<tr>
<td>Fiber (g/day)</td>
<td>19.3 ± 10.4</td>
<td>20.8 ± 12.4</td>
<td>21.9 ± 10.6</td>
</tr>
<tr>
<td>% Kcal from Fiber</td>
<td>3.4 ± 1.5</td>
<td>3.8 ± 1.6</td>
<td>3.8 ± 1.5</td>
</tr>
<tr>
<td>Cholesterol (mg/day)</td>
<td>742.0 ± 619.9††</td>
<td>203.9 ± 144.7</td>
<td>209.9 ± 108.4</td>
</tr>
<tr>
<td>Sugar (g)</td>
<td>80.7 ± 54.5</td>
<td>80.7 ± 45.4</td>
<td>96.0 ± 63.1</td>
</tr>
<tr>
<td>% Kcal from Sugar</td>
<td>13.7 ± 8.9</td>
<td>15.1 ± 7.3</td>
<td>16.7 ± 9.2</td>
</tr>
</tbody>
</table>

Values are mean ± SD; † significant compared to High Carbohydrate Breakfast (p<0.05); †† significant compared to Egg Beaters (p<0.05); P values are obtained from GLM
Conclusions

- We found no evidence of adverse effects of daily egg ingestion on any cardiac risk factors in adults with CAD over a span of 6 weeks

- Our findings, and the overall weight of evidence, argue against the exclusion of eggs from heart-healthy diets, even among those with actual coronary disease

- There may be net harm to overall diet quality, and health, by excluding eggs from one’s diet

The Forest Through the Trees: Repercussions Beyond Breakfast
David Katz, M.D.
Director, Yale Prevention Research Center

Living (and Dying) on a Diet of Unintended Consequences
Posted: 09/11/2012 8:01 pm
Concerns, in Context
Deviled Details


- Eggs, Too, May Provoke Bacteria to Raise Heart Risk
  - By Gina Kolata
  - Published: April 24, 2013

The New York Times
Eggspectations & Implications
 limiting dietary cholesterol to less than 300 mg per day, but aiming at further reductions of dietary cholesterol to less than 200 mg per day in persons with or at high risk for CVD or T2D.
Practical Application

- Encourage patients to choose a meal pattern that:
  - Is based on nutrient-rich, whole foods
  - Derives carbohydrate from vegetables, fruits, dairy and legumes; minimizes refined starch, added sugar
  - Spaces macronutrients and calories evenly throughout the day
    - Aim to include 25-30 grams of protein in place of refined carbohydrates at each meal, particularly breakfast
  - Incorporates healthy fats
  - Aligns with the MyPlate model
Resources

- Yale-Griffin Prevention Research Center (yalegriffinprc.org)

- Egg Nutrition Center (eggnutritioncenter.org)
  - Continuing Education Opportunities
  - Patient/Client Education Materials

- ChooseMyPlate.gov

- The Academy of Nutrition and Dietetics (eatright.org)
Thank you!

David L. Katz, MD, MPH, FACPM, FACP
Director, Yale Prevention Research Center
President, Turn the Tide Foundation, Inc.
130 Division St.
Derby, CT 06418
(203) 732-1265
David.Katz@yale.edu

Special thanks to Dr. Valentine Yanchou Njike
and the PRC Vascular Lab