Monica L. Bertoia, MPH, PhD

Increased Consumption of Fruits and Vegetables and Weight Change Over Time

FINANCIAL DISCLOSURE:
Eric Rimm has separate unassociated funding jointly with the University of East Anglia to conduct observational and experimental studies of blueberries and CVD health outcomes from the USDA/US Blueberry highbush council.
Increased Consumption of Fruits and Vegetables and Weight Change Over Time

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Objective

To examine the association between increased intake of fruits and vegetables and weight change over time

- Total fruits, total vegetables
- Subtypes
- Individual fruits and vegetables
- High and low fiber
- High and low glycemic load (GL)
3 Prospective Cohorts

NHS I
Nurses’ Health Study
121,701 female nurses age 30-55 y

HPFS
Health Professionals Follow-up Study
51,529 male health professionals age 40-75 y

NHS II
Nurses’ Health Study II
116,430 female nurses age 25-42 y

First FFQ
Measurement of Diet and Weight

- Weight self-reported every 2 years via questionnaire
- 131-item, validated, semi-quantitative, FFQ every 4 years

<table>
<thead>
<tr>
<th>Study</th>
<th>Follow-up period</th>
<th>4-year intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHS I</td>
<td>1986 – 2010 (24 years)</td>
<td>6</td>
</tr>
<tr>
<td>HPFS</td>
<td>1986 – 2010 (24 years)</td>
<td>6</td>
</tr>
<tr>
<td>NHS II</td>
<td>1991 – 2007 (16 years)</td>
<td>4</td>
</tr>
</tbody>
</table>
Exclusion Criteria

Baseline
• Obesity, diabetes, cancer, CVD, pulmonary/renal/liver disease
• > 65 years old
• Missing lifestyle data
• Implausible energy intake or > 70 blanks on FFQ

Censoring
• Diabetes, cancer, pulmonary/renal/liver disease (6 years prior)
• CVD (at time of diagnosis)
• > 65 years old
Statistical Analysis

• Multivariable linear regression with robust variance
• Exposure: 4y change in F&V (servings/d)
• Outcome: 4y change in weight (lbs) 
  *during the same 4-year interval*
Covariates

Change in:
- Smoking status
- Physical activity level
- Hours sitting/watching TV
- Hours of sleep

Change in intake of:
- Fried potatoes
- Juice
- Whole grains
- Refined grains
- Fried foods
- Whole-fat dairy
- Low-fat dairy
- Sugar-sweetened beverages
- Sweets
- Processed meats
- Non-processed meats
- % trans fat
- Alcohol
- Seafood

Baseline age
Baseline BMI
## Baseline Characteristics, mean (SD)

<table>
<thead>
<tr>
<th></th>
<th>HPFS</th>
<th>NHS 1</th>
<th>NHS 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>n</strong></td>
<td>17,219</td>
<td>35,408</td>
<td>62,975</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Baseline Characteristics</strong></th>
<th>HPFS</th>
<th>NHS 1</th>
<th>NHS 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>46.8 (2.9)</td>
<td>48.6 (2.4)</td>
<td>36.3 (3.8)</td>
</tr>
<tr>
<td><strong>Weight (lbs)</strong></td>
<td>174 (13)</td>
<td>140 (9)</td>
<td>137 (17)</td>
</tr>
<tr>
<td><strong>BMI (kg/m^2)</strong></td>
<td>24.6 (1.4)</td>
<td>23.5 (1.3)</td>
<td>22.8 (2.5)</td>
</tr>
<tr>
<td><strong>Average 4-year weight change (lbs)</strong></td>
<td>2.1</td>
<td>2.8</td>
<td>4.9</td>
</tr>
<tr>
<td><strong>Physical activity (MET-hr/wk)</strong></td>
<td>23.5 (19.7)</td>
<td>15.0 (10.0)</td>
<td>21.7 (24.4)</td>
</tr>
<tr>
<td><strong>Alcohol (servings/d)</strong></td>
<td>0.9 (0.7)</td>
<td>0.5 (0.4)</td>
<td>0.3 (0.4)</td>
</tr>
<tr>
<td><strong>Sleep (hours/d)</strong></td>
<td>7.1 (0.5)</td>
<td>7.0 (0.5)</td>
<td>7.0 (0.9)</td>
</tr>
<tr>
<td><strong>Total fruit without juice (servings/d)</strong></td>
<td>1.5</td>
<td>1.5</td>
<td>1.2</td>
</tr>
<tr>
<td><strong>Total vegetables (servings/d)</strong></td>
<td>2.9</td>
<td>3.2</td>
<td>3.1</td>
</tr>
<tr>
<td><strong>Low-fat dairy (servings/d)</strong></td>
<td>0.9</td>
<td>0.9</td>
<td>1.1</td>
</tr>
<tr>
<td><strong>Whole grains (servings/d)</strong></td>
<td>1.5</td>
<td>0.8</td>
<td>1.3</td>
</tr>
</tbody>
</table>
Total Fruits & Vegetables

Weight Change Associated with Each Increased Daily Serving, per 4-year Interval (lbs)
Weight Change Associated with Each Increased Daily Serving, per 4-Year Interval (lbs)

- Berries (strawberries, blueberries)
- Melon (cantaloupe, watermelon)
- Citrus Fruits (oranges, grapefruit)

HPFS
NHS1
NHS2
Pooled
Vegetable Subtypes

**Cruciferous Vegetables**
- broccoli, cauliflower, cabbage, brussels sprouts

**Green Leafy Vegetables**
- kale, spinach, romaine & iceberg lettuce

**Legumes**
- peas, beans tofu/soy

Weight Change Associated with Each Increased Daily Serving, per 4-Year Interval (lbs)
Weight Change Associated with Each Increased Daily Serving, per 4-Year Interval (lbs)
Individual Vegetables (Part 1)

Weight Change Associated with Each Increased Daily Serving, per 4-Year Interval (lbs)
Individual Vegetables (Part 2)

Weight Change Associated with Each Increased Daily Serving, per 4-Year Interval (lbs)

- Tomatoes
- Winter Squash
- Onions
- Cabbage
- Potatoes
- Peas
- Corn

Weight Range:
- -1.00
- -0.50
- 0.00
- 0.50
- 1.00
- 1.50
- 2.00
- 2.50
- 3.00

Notes:
- Pooled
Fruit & Vegetable Fiber Content

-1.50
-1.00
-0.50
0.00
0.50

Weight Change Associated with Each Increased Daily Serving, per 4-Year Interval (lbs)

Low Fiber Vegetables
High Fiber Vegetables
Low Fiber Fruit
High Fiber Fruit

HPFS
NHS1
NHS2
Pooled
Fruit & Vegetable GL

Weight Change Associated with Each Increased Daily Serving, per 4-Year Interval (lbs)
Summary

• Increased total F&V intake inversely associated with weight change
• Magnitude of change larger for fruits vs. vegetables
• Wide-ranging associations for each type
• Increased intake of corn, peas, potatoes positively associated with weight change
Public Health Implications & Future Direction

• Advice to “eat less and exercise more” may not be optimal

• Despite higher carbohydrate content, fruits more strongly associated with weight change than vegetables
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  • R01 CA67262
  • UM1 CA167552
  • R01 HL35464

• HPFS and NHS Participants
• Channing Laboratory
Fruit

- Pooled
- NHS2
- NHS1
- HPFS

- Low fiber, high GL
- Low fiber, low GL
- High fiber, high GL
- High fiber, low GL
Vegetables

HPFS

NHS1

NHS2

Pooled

Low fiber, high GL

Low fiber, low GL

High fiber, high GL

High fiber, low GL
Strengths & Limitations

- Repeated, validated FFQ
- 24 y follow-up
- 115,602 adults

- FFQ measurement error
- Unclear timing
- Population limited to mainly White, educated adults