Plant Foods & Plant-Based Diets: Protective Against Childhood Obesity?

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Brief Background

1 in 10 children is overweight

Secular changes in diet over time

- ↑ Total Energy
- ↓ Fat (% energy)
- ↑ Carbohydrate (% energy)
- ↓ Fiber
- ↑ Sugar-sweetened beverages
- ↑ Refined food and fast food
- ↓ Meals at home

Low intakes of plant-based foods

- Fruits, vegetables, whole grains
Fruits and Vegetables

Nine cross-sectional studies

- **BMI**
  - ↓ for both fruit and vege (Kelishadi et al, 2003)
  - NS for both fruit and vege (Humenikova & Gates, 2007; Wang et al, 2007; Tanasescu et al, 2000)

- **% body fat**
  - ↓ for fruit (Baric et al, 2003)
  - NS fruit (Vagastrand et al, 2007)

- **Overweight/obesity**
  - ↓ for both fruit and vege (Violante et al, 2005; Roseman et al, 2007)
  - Inconsistent across age groups and only significant in boys 6-7 y (Violante et al, 2005)
  - NS for vege (Hanley et al, 2000)

Three prospective studies showed no significant association with change in BMI with both fruit and vege (Newby et al, 2003; Field et al, Faith et al, 2003)

Evidence is limited and inconsistent. Additional prospective research is needed.

Perhaps preparation matters!
Breads and cereals were not associated with obesity in a multivariate adjusted model (data not provided).

**Table 3. Food Group Intakes and Annual Weight Change Among 1379 Children Participating in the North Dakota WIC Program**

<table>
<thead>
<tr>
<th>Regression Models</th>
<th>Change in Weight, kg/y, β (SE)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ND breads and grains only (model 1), servings per day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted for age and sex†</td>
<td>−0.18 (0.04)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Multivariate adjusted†</td>
<td>−0.19 (0.04)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Without energy§</td>
<td>−0.13 (0.03)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

**Evidence is limited and inconsistent. Additional prospective research is needed.**

**All grains are not created equal!**
Most studies show protective associations:

- % body fat (Vagstrand et al, 2007; Baric et al, 2003)
- BMI (Kafatos et al, 2005; Baric et al, 2003; Albertson et al, 2003; Kosti et al, 2007; Gibson et al, 1995)
- Waist Circumference (Kafatos et al, 2005; Baric et al, 2003)
- Overweight (Albertson et al, 2003)
- BMI z-score (Barton et al, 2005, prospective)

Some inconsistencies

- No association with BMI (Baric et al, 2003)
- Variability by sex (Vagastrand et al, 2007)

Does type of cereal matter?
Whole vs refined grain?
Fiber content?
Sugar content?
Only 1 prospective study!

Generally consistent with adult data in showing a protective effect but limited data.

OR = 0.67
CI: 0.52-0.87, \( P < 0.002 \)

High-Protein Foods

- No significant associations:
  - **Soy** not associated with BMI among Iranian adolescents 11-18 y \((r = 0.02, p = 0.48)\) (Kelishadi et al, 2003)
  - **Nuts** not associated with BMI in same study \((r = 0.01, p = 0.57)\) (Kelishadi et al, 2003)
  - **Nuts** and **pulses** not associated with BMI \((\text{OR}=0.75, \text{CI}: 0.40, 1.03 \text{ for nuts} \text{ and } \text{OR}=1.18, \text{CI}: 0.98-1.40 \text{ for pulses})\) among girls 6-7 y (Violante al, 2005)
  - **Legumes** not associated with BMI \((\text{data not shown})\) among children 7-10 y (Tanasescu al, 2000)

- Very few studies!
Vege protein: lower BMI and body fat 1-6 y

Animal protein (% energy): 6 months – 6 years

Vegetable protein (% energy): 6 months – 6 years

### Table 4

Adjusted mean body fat percentages (BF%) at 7 y of age according to tertiles of protein intake (% of energy) at ages 12 mo and 5–6 y for participants of the DONALD Study (n = 203)\(^2\)

<table>
<thead>
<tr>
<th></th>
<th>Tertiles of protein intake</th>
<th></th>
<th></th>
<th></th>
<th>P for trend(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Animal protein</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 mo</td>
<td>16.20 (15.23, 17.25)</td>
<td>17.21 (16.24, 18.23)</td>
<td>18.21 (17.12, 19.15)</td>
<td>0.008</td>
<td></td>
</tr>
<tr>
<td>5–6 y</td>
<td>16.83 (16.14, 17.55)</td>
<td>16.95 (16.25, 17.68)</td>
<td>18.02 (17.29, 18.79)</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td><strong>Vegetable protein</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 mo</td>
<td>17.64 (16.47, 18.89)</td>
<td>16.66 (15.70, 17.67)</td>
<td>17.28 (16.12, 18.52)</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>5–6 y</td>
<td>17.42 (16.55, 18.34)</td>
<td>17.48 (16.78, 18.21)</td>
<td>16.89 (16.06, 17.76)</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td><strong>Dairy protein</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 mo</td>
<td>16.88 (15.90, 17.92)</td>
<td>16.75 (15.75, 17.81)</td>
<td>17.99 (17.01, 19.02)</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>5–6 y</td>
<td>16.80 (16.08, 17.55)</td>
<td>17.21 (16.53, 17.96)</td>
<td>17.60 (17.00, 18.48)</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td><strong>Meat protein</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 mo</td>
<td>17.77 (16.74, 18.85)</td>
<td>17.56 (16.57, 18.61)</td>
<td>16.41 (15.46, 17.42)</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>5–6 y</td>
<td>17.07 (16.35, 17.82)</td>
<td>17.33 (16.59, 18.09)</td>
<td>17.44 (16.71, 18.21)</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td><strong>Cereal protein</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 mo</td>
<td>16.92 (15.96, 17.95)</td>
<td>17.06 (16.12, 18.07)</td>
<td>17.70 (16.65, 18.82)</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>5–6 y</td>
<td>17.36 (16.58, 18.19)</td>
<td>17.40 (16.68, 18.14)</td>
<td>17.06 (16.34, 17.80)</td>
<td>0.2</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Values are adjusted geometric means (95% CI).

\(^2\) Based on multiple linear regression analyses (dietary intakes as continuous variables) with adjustment for sex, total energy and fat (% of energy) intake, siblings in the dataset (yes or no), firstborn status (yes or no), maternal overweight (BMI ≥ 25; yes or no), and lnBF% at baseline (6 mo and 3–4 y, respectively).

\(^3\) Models with vegetable or cereal protein intake as explanatory variables also included fiber intake (g/kcal).

Fiber

- Four cross-sectional studies
  - BMI
    - NS (Humenikova & Gates, 2007)
  - % body fat
    - NS (Tucker et al, 1997; Guillaume et al, 1998)
  - Overweight/obesity
    - ↓ (OR=0.69, CI: 0.47) (Hanley et al, 2000)
    - ↓ (Hassapidou et al, 2006)

- Two prospective studies showed no significant association with change in weight or change in BMI
  (Newby et al, 2003; Berkey et al, 2000)

Limited evidence does not suggest a protective association. Additional prospective research is needed.

Need to consider subtypes of fiber as well as sources.
Dietary Patterns (Empirical patterns)

- A “total diet” method
- Limited research using this approach to examine diet and obesity in children - 3 published studies:

  Constant
  Low-fat
  Medium-fat
  High-fat

  (Alexy et al, 2004)

  Animal Foods
  Korean Healthy Sweets

  (Shin et al, 2007)

  Fruit/salad/Cereal/Fish
  High Fat and Sugar Vegetables

  (McNaughton et al, 2008)
“Animal Foods” pattern associated with overweight in Koreans

Table 5. Comparison of quintiles (Q) with lowest quintile (Q1) for each dietary pattern by overweight and health characteristics in 1441 Korean preschool children

(Adjusted odds ratios and 95% confidence intervals)

<table>
<thead>
<tr>
<th>Compared with Q1†</th>
<th>Q2 (n 288)</th>
<th>Q3 (n 289)</th>
<th>Q4 (n 288)</th>
<th>Q5 (n 288)</th>
<th>P for Wald χ²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR</td>
<td>95% CI</td>
<td>OR</td>
<td>95% CI</td>
<td>OR</td>
</tr>
<tr>
<td>Korean healthy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overweight</td>
<td>1·34</td>
<td>0·82, 2·20</td>
<td>1·19</td>
<td>0·72, 1·96</td>
<td>1·37</td>
</tr>
<tr>
<td>Health status‡</td>
<td>0·69</td>
<td>0·49, 0·97</td>
<td>0·78</td>
<td>0·56, 1·10</td>
<td>0·73</td>
</tr>
<tr>
<td>Animal foods</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overweight</td>
<td>0·83</td>
<td>0·51, 1·35</td>
<td>0·66</td>
<td>0·39, 1·10</td>
<td>1·01</td>
</tr>
<tr>
<td>Health status‡</td>
<td>1·12</td>
<td>0·80, 1·58</td>
<td>1·47</td>
<td>1·05, 2·07</td>
<td>1·09</td>
</tr>
<tr>
<td>Sweets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overweight</td>
<td>1·25</td>
<td>0·81, 1·94</td>
<td>0·92</td>
<td>0·59, 1·45</td>
<td>1·04</td>
</tr>
<tr>
<td>Health status‡</td>
<td>0·96</td>
<td>0·68, 1·35</td>
<td>1·15</td>
<td>0·82, 1·62</td>
<td>0·82</td>
</tr>
</tbody>
</table>

* OR adjusted for household income, preschool location, and child’s age, sex and total energy intake, and duration of television watching (only for overweight).
† n 288 in Q1.
‡ 40-5% Children’s health status was inferior or similar to their peers.

Total Dietary Quality

DQI components
- % Added sugar
- % fat
- % Linoleic acid
- % Linolenic acid
- % DHA+EPA
- Grains (oz)
- Whole grains (oz)
- Fruits (cup)
- Veges (cup)
- 100% fruit juice
- Dairy (cup)
- Iron (mg/dL)
- Energy balance

Figure 1 - The proportion of preschoolers at risk for overweight or overweight with increasing Revised Children’s Diet Quality Index (RC-DQI) total score quartiles in a nationally representative sample of American children 2-5 years old (n = 1,521)

Mechanisms (just a few!)

- Multiple mechanisms likely at play
- Energy density
- Satiety and satiation
- Resistant starch
- Glycemic index
- Substitution/replacement
- Total energy
**Methodological Considerations & Future Research Directions**

**Methodological Issues**
- Diet assessment
- Dietary under-reporting
- Growth and development
- Changing food supply and dietary databases
- Generalizability & Potential interactions (sex, ethnicity, growth)

**Future Directions**
- More rigorous methods
  - Prospective studies
  - Adjustment for confounders
- Focus on total diet and diet patterns
- Diet-Gene Interactions
Concluding Thoughts

- Limited and weak evidence to show that fruits, veges, grains, fiber, and high-protein vege foods can prevent childhood obesity
- Many other health reasons to consume a plant-based diet so can still be recommended for other reasons but need to remember 3 things
Plant-Based Diets: One Size Needs Not Fit All!

Food Guide Pyramids To Suit Different Tastes and Diverse Cultures

http://www.oldwayspt.org/