Plant-based diet patterns, plant foods, and weight control

Observations from NHANES and applications

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Population-based studies have shown that:

– Vegetarians have lower body mass index than non-vegetarians

– Vegetarian dietary patterns are lower in calories than non-vegetarian
Vegetarian Diets vs Dietary Guideline Recommendations

**Characteristics of vegetarian diets**
- Lower calorie intake
- Lower total fat
- Lower saturated fat
- Lower cholesterol
- Lower sodium
- Higher fiber

**Dietary Guidelines for Americans**
- Decrease calories from food and beverage
- Choose foods low in saturated fat and cholesterol
- Decrease sodium intake
- Choose fiber-rich foods often
Problem Nutrients?

Iron
Vitamin B12
Zinc
Protein
Calcium
Vitamin D
So we asked -

Can a vegetarian diet be an approach for weight management without compromising diet quality?
Low Calorie Dieting

Academy of Nutrition and Dietetics evidence analysis supports reduction of 500 to 1000 kcal per day as the basis of dietary recommendations for weight management.
Methods

• Analysis of NHANES (1999-2004) anthropometric and one day dietary data
• Lacto-ovo vegetarian diet defined by intakes of participants who did not eat meat, poultry or fish on the day of the survey
• Weight loss diet defined by intakes of participants who consumed 500 kcal less than their estimated energy requirements
• Mean nutrient intakes and BMIs were adjusted for energy, gender and ethnicity

J Am Diet Assoc 2011;111:819-827
### Body Mass Index Comparison

**NHANES 1999-2004 participants ages 19 years and older**

<table>
<thead>
<tr>
<th></th>
<th>Non-vegetarians</th>
<th>Mean BMI kg/m²</th>
<th>Vegetarians</th>
</tr>
</thead>
<tbody>
<tr>
<td>8,225 non-dieters</td>
<td>26.7 ± 0.1</td>
<td>25.2 ± 0.3</td>
<td>432 non-dieters</td>
</tr>
<tr>
<td>4,216 dieters</td>
<td>31.4 ± 0.2</td>
<td>29.8 ± 0.4</td>
<td>419 dieters</td>
</tr>
<tr>
<td>12,441 total</td>
<td>26.7 ± 0.1</td>
<td>25.2 ± 0.3</td>
<td>851 total</td>
</tr>
</tbody>
</table>

p<0.01 within each row

J Am Diet Assoc 2011;111:819-827
Dietary Intakes
Vegetarians vs Non-vegetarians

Vegetarians consumed:

364 fewer calories and

<table>
<thead>
<tr>
<th>Higher</th>
<th>Lower</th>
</tr>
</thead>
<tbody>
<tr>
<td>fiber</td>
<td>total fat</td>
</tr>
<tr>
<td>vitamins A, C, and E</td>
<td>saturated fat</td>
</tr>
<tr>
<td>magnesium</td>
<td>cholesterol</td>
</tr>
<tr>
<td>calcium</td>
<td>sodium</td>
</tr>
<tr>
<td>iron</td>
<td>protein</td>
</tr>
<tr>
<td>thiamin</td>
<td>vitamin B$_{12}$</td>
</tr>
<tr>
<td>riboflavin</td>
<td>zinc</td>
</tr>
<tr>
<td>folate</td>
<td>niacin</td>
</tr>
</tbody>
</table>

J Am Diet Assoc 2011;111:819-827
Dietary Intakes
Vegetarians vs Non-vegetarians

Vegetarians consumed:

Higher
✓ grains
✓ fruit
✓ dark green vegetable
✓ legumes
✓ nuts
✓ soy
✓ total dairy

Lower
✓ potato
✓ discretionary fat

J Am Diet Assoc 2011;111:819-827
Effect of Lower Calorie Intake on Iron

![Bar chart showing iron intake comparison between dieters and non-dieters]

- Vegetarians
- Non-vegetarians

- Non-dieters: 17.9 mg iron (P<0.01)
- Dieters: 15.4 mg iron vs 14.8 mg iron

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Effect of Lower Calorie Intake on Zinc and Vitamin B12

J Am Diet Assoc 2011;111:819-827
Effect of Lower Calorie Intake on Protein

![Bar graph showing protein intake for non-dieters and dieters, with and without a vegetarian diet.](image)

- Non-dieters:
  - Vegetarians: 62.5 grams, P<0.01
  - Non-vegetarians: 83.9 grams, P<0.01

- Dieters:
  - Vegetarians: 64.4 grams, P<0.01
  - Non-vegetarians: 83.1 grams, P<0.01

*J Am Diet Assoc 2011;111:819-827*
Effect of Lower Calorie Intake on Fiber

- Vegetarians:
  - Non-dieters: 23.4 grams, P<0.01
  - Dieters: 16 grams, P<0.01

- Non-vegetarians:
  - Non-dieters: 15.8 grams
  - Dieters: 14.3 grams, P<0.01

J Am Diet Assoc 2011;111:819-827
Effect of Lower Calorie Intake on Magnesium

![Bar chart showing magnesium levels in non-dieters and dieters.](chart.png)

- Non-dieters: Vegetarians: 349 mg, Non-vegetarians: 286 mg
- Dieters: Vegetarians: 283 mg, Non-vegetarians: 268 mg

P < 0.01

J Am Diet Assoc 2011;111:819-827
Effect of Low Calorie Intake on Vitamin A, Vitamin C, Vitamin E

- Vitamin A: Vegetarians 801 mcg, Non-vegetarians 619 mcg, P<0.01
- Vitamin C: Vegetarians 127 mg, Non-vegetarians 96 mg, P<0.01
- Vitamin E: Vegetarians 8.8 mg, Non-vegetarians 7.2 mg, P<0.01

Dieters vs. Non-dieters

Vegetarians

- Vitamin A: 600 mcg
- Vitamin C: 91 mg
- Vitamin E: 7.5 mg

Non-vegetarians

- Vitamin A: 570 mcg
- Vitamin C: 81 mg
- Vitamin E: 6.6 mg

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Healthy Eating Index Scores

- Non-dieters
  - Vegetarians: 53
  - Non-vegetarians: 49.7
  - P<0.01

- Dieters
  - Vegetarians: 47.3
  - Non-vegetarians: 51
  - P<0.01

J Am Diet Assoc 2011;111:819-827
Summary

• Adjusted mean intakes of several nutrients were highest for non-dieting vegetarians
• Adjusted mean intakes of shortfall nutrients for vegetarians were not below recommendations
• Vegetarian diets at lower calorie intake result in decreased diet quality
Usual Intakes

• Analysis of NHANES 2001 – 2008 dietary data
• National Cancer Institute method used to estimate usual nutrient intakes and proportions of the population below defined cutoff values
• Prevalence of inadequacy reported as percentage of the population with usual intakes below Estimated Average Requirements (EAR)
### Percentages of population below EAR

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Vegetarian</th>
<th>Non-vegetarian</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>37%</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>Vitamin C</td>
<td>43%</td>
<td>48%</td>
<td></td>
</tr>
<tr>
<td>Vitamin E</td>
<td>90%</td>
<td>94%</td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td>62%</td>
<td>61%</td>
<td></td>
</tr>
</tbody>
</table>


## Percentages of population below EAR

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Non-vegetarian</th>
<th>Vegetarian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>8%</td>
<td>17%</td>
</tr>
<tr>
<td>Calcium</td>
<td>50%</td>
<td>52%</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>3%</td>
<td>28%</td>
</tr>
<tr>
<td>Zinc</td>
<td>10%</td>
<td>51%</td>
</tr>
<tr>
<td>Protein</td>
<td>1%</td>
<td>34%</td>
</tr>
</tbody>
</table>
Summary

• Prevalence of inadequate nutrient intakes were similar for vegetarians and non-vegetarians

• Largest differentials between vegetarian and non-vegetarian were
  – Zinc
  – Protein
  – Vitamin B12
Conclusion

While quality and adequacy of a lacto-ovo vegetarian diet may be similar to or better than that of non-vegetarians, there is a critical point at which lower energy intake results in compromised diet quality.
Recommendations for Practice

- Recommend vegetarian eating pattern without energy restriction

- Optimize intake of vitamin B12, zinc, and protein

- Increase vitamins A, C, and E, calcium, magnesium, and fiber
  - Both vegetarians and non-vegetarians
Study Limitations and Recommendations

• Subjects defined as vegetarians may have avoided eating meat on the day of the survey for reasons other than vegetarianism.

• Additional work is needed to develop survey questions that would define vegetarians appropriately.

• To more accurately represent nutrient intakes of vegetarians, oversampling of vegetarians for NHANES may be necessary.
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