Effective Vegetarian Diets for Weight Loss and Glycemic Control: a Low-Fat Vegan Diet Perspective

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Adjunct Associate Professor of Medicine
The George Washington University School of Medicine
The Rationale for Plant-Based Diets
Diabetes Prevalence in Japan

In adults over age 40:

Prior to 1980: 1-5%

Rising Fat Intake in Japan

Murata M. Am J Clin Nutr 2000;72(suppl):1379S-83S.
Falling Carbohydrate Intake in Japan

Carbohydrate (grams/day)

Murata M. Am J Clin Nutr 2000;72(suppl):1379S-83S.
Overweight and Obesity in Japan

Prevalence in Men

Diabetes Prevalence in Japan

In adults over age 40:

Prior to 1980: 1-5%

By 1990: 11-12%

Lifestyle Heart Trial

Dean Ornish, M.D.
Preventive Medicine
Research Institute
Sausalito, California

Randomized trial:
lifestyle intervention
vs.
usual care

Lifestyle Heart Trial

Experimental program:
1. Vegetarian foods
2. Half-hour walk daily
3. Manage stress
4. Avoid tobacco

<table>
<thead>
<tr>
<th></th>
<th>Experimental</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cholesterol</td>
<td>↓ 24%</td>
<td>↓ 5%</td>
</tr>
<tr>
<td>LDL</td>
<td>↓ 37%</td>
<td>↓ 3%</td>
</tr>
<tr>
<td>Weight</td>
<td>↓ 22 lbs</td>
<td>↑ 3 lbs</td>
</tr>
<tr>
<td>Reversal</td>
<td>82% of participants</td>
<td>42% of participants</td>
</tr>
</tbody>
</table>

Fat Content
(Percentage of Calories from Fat)

- Leanest beef: 29%
- Skinless chicken breast: 23%
- Sea trout: 32%
- White tuna: 16%
- Broccoli: 8%
- Beans: 4%
- Rice: 1–5%
- Sweet Potato: 1%
Protein and Loss of Kidney Function

Nurses’ Health Study (Harvard):

Among women with mild renal insufficiency (GFR 55 to < 80 mL/min per 1.73 m²) followed for 11 years:

Every 10 g non-dairy animal protein $\rightarrow$ 1.21 mL/min per 1.73 m² drop in GFR

GFR = Glomerular filtration rate
Prevalence of Decreased Kidney Function

GFR = Glomerular filtration rate, mL/min per 1.73 m²
Dietary Intervention for Neuropathic Pain

Milton Crane, MD
Weimar Institute
Weimar, California

21 volunteers with painful diabetic neuropathy

2-week intervention: Low-fat, vegan diet
Daily 30-minute walk

Result: 17 became pain-free, 4 had partial improvement

A Controlled Trial of the Effect of a Low-Fat, Vegan Diet on Body Weight and Metabolism

Neal D. Barnard, M.D.
Anthony R. Scialli, M.D.,
Gabrielle Turner-McGrievy, M.S., R.D.
Amy J. Lanou, Ph.D.
Jolie Glass, M.S.

Methods

- 64 overweight (BMI 26-44 kg/m²) postmenopausal women
- Randomly assigned to low-fat vegan or NCEP Step II diet
- Exercise levels held constant
- 14-week study
Weight Loss at 14 Weeks

- Vegan Diet (N=29): 5.8 kg (13 lbs)
- Step II Diet (N=30): 3.8 kg (8 lbs)
Insulin Sensitivity

Vegan group: 24% increase

Step II group: no significant change

Plant-Based Dietary Intervention in Type 2 Diabetes

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Lise Gloede, R.D., C.D.E.
Stanley Talpers, M.D.
Paul J. Poppen, Ph.D.
Amber Green, R.D.
Brent Jaster, M.D.
Kim Seidl, M.S., R.D
Susan Levin, R.D.
Earnest Noble, M.D.
Terry Ritchie, Ph.D.
Robyn Webb, M.S.

George Washington University
George Washington University
University of Toronto
University of North Carolina
Private practice, Arlington, VA
George Washington University
George Washington University
PCRM
PCRM
PCRM

Funding: National Institute of Diabetes and Digestive and Kidney Diseases, NIH
Diabetes Action Research and Education Foundation
Study design:

Vegan, low-fat, low-GI diet (n = 49) vs Diet based on ADA guidelines (n = 50)

22-week study with 1-year follow-up

Dependent measures: A1c, weight, lipids, urinary albumin
Diets:

Low-fat, vegan group:
- Avoid animal products
- Avoid added oils
- Favor low-glycemic index foods

ADA group:
- Saturated fat < 7%
- Carbohydrate + monounsaturated fat 60-70%
- Cholesterol ≤ 200 mg per day
- If overweight, cut calories (- 500 kcal per day)

All participants in both groups took vitamin B\textsubscript{12} 100 mcg every other day.
Typical Day’s Meals

**Breakfast**
- Oatmeal with cinnamon and raisins
- Half cantaloupe
- Rye toast, dry

**Lunch**
- Vegetarian chili
- Green salad

**Snack**
- Banana

**Dinner**
- Pasta with marinara sauce
- Steamed broccoli
Protocol:

1-hour diet instruction by RD with expertise in assigned diet

Weekly group meetings

No changes in exercise

Medications adjusted only in cases of symptomatic hypoglycemia (glucose <65 mg/dl) by clinician blind to group assignment
<table>
<thead>
<tr>
<th></th>
<th>Vegan Group</th>
<th>ADA Gr</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>49</td>
<td>50</td>
</tr>
<tr>
<td>Completers at 22 weeks</td>
<td>49 (100%)</td>
<td>50 (100%)</td>
</tr>
<tr>
<td>Completers at 74 weeks</td>
<td>42 (86%)</td>
<td>45 (90%)</td>
</tr>
</tbody>
</table>
Dietary Intake at Weeks 0, 22, and 74 (N = 38 vegan, 39 ADA)

**Energy**
- ADA vs. Vegan: P < 0.99

**Fat**
- ADA vs. Vegan: P < 0.0001

**Protein**
- ADA vs. Vegan: P = 0.0007

**Carbohydrate**
- ADA vs. Vegan: P < 0.0001
## Diabetes Medication Changes (0-22 weeks)

<table>
<thead>
<tr>
<th></th>
<th>Vegan Group N = 49</th>
<th>ADA Group N = 50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net reductions</td>
<td>21 (43%)</td>
<td>13 (26%)</td>
</tr>
<tr>
<td>Net increases*</td>
<td>4 (8%)</td>
<td>4 (8%)</td>
</tr>
<tr>
<td>Total</td>
<td>25 (51%)</td>
<td>17 (34%)</td>
</tr>
</tbody>
</table>

* Medication increases were prescribed by participants’ personal physicians and were not part of the study protocol.
## Diabetes Medication Changes (0-74 weeks)

<table>
<thead>
<tr>
<th></th>
<th>Vegan Group</th>
<th>ADA Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N = 49</td>
<td>N = 50</td>
</tr>
<tr>
<td>Net reductions</td>
<td>17 (35%)</td>
<td>10 (20%)</td>
</tr>
<tr>
<td>Net increases</td>
<td>7 (14%)</td>
<td>12 (24%)</td>
</tr>
<tr>
<td>Mixed changes*</td>
<td>11 (22%)</td>
<td>7 (14%)</td>
</tr>
<tr>
<td>Total number with any changes</td>
<td>35 (71%)</td>
<td>29 (58%)</td>
</tr>
</tbody>
</table>

* Changes in opposite directions in 2 or more medications.
Hemoglobin A1c at Baseline and at 11 and 22 Weeks

(n = 49 vegan, 50 ADA)

P = .089
Hemoglobin A1c at Baseline and at 11 and 22 Weeks

Individuals with no medication changes, n = 24 vegan, 33 ADA

<table>
<thead>
<tr>
<th>Week</th>
<th>Vegan</th>
<th>ADA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>8.07</td>
<td>8.07</td>
</tr>
<tr>
<td>11</td>
<td>7.42</td>
<td>7.88</td>
</tr>
<tr>
<td>22</td>
<td>6.84</td>
<td>7.50</td>
</tr>
</tbody>
</table>

P = 0.01
Hemoglobin A1c Changes from Baseline to 22 Weeks
Individuals with no medication changes, n = 24 vegan, 33 ADA

Vegan

ADA

A1c change

Mean = -0.38

Mean = -1.23

P = .01
Hemoglobin A1c, All Participants
(n = 49 vegan, 50 ADA)

Data shown are last values before any change to hypoglycemic medications carried forward. For between-group comparison of changes from baseline to final values, P = 0.03.
Hemoglobin A1c
Participants with No Medication Changes (0-74 Weeks)
(n = 14 vegan, 21 ADA)

P = 0.14 for difference between groups in change from weeks 0 to 74.
Body Weight at Baseline and at 11 Weeks and 22 Weeks
\((n = 49 \text{ vegan}, 50 \text{ ADA})\)

<table>
<thead>
<tr>
<th></th>
<th>Week 0</th>
<th>Week 11</th>
<th>Week 22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegan</td>
<td>97.0</td>
<td>96.2</td>
<td>95.0</td>
</tr>
<tr>
<td>ADA</td>
<td>99.3</td>
<td>93.5</td>
<td>91.1</td>
</tr>
</tbody>
</table>

\(P = .082\)
Body Weight at Baseline and at 11 Weeks and 22 Weeks
For Individuals with unchanged diabetes medications (n = 24 vegan, 33 ADA)

![Graph showing body weight changes over weeks for vegan and ADA groups.](Image)

**Vegan**
- Week 0: 102.4 kg
- Week 11: 98.6 kg
- Week 22: 96.9 kg

**ADA**
- Week 0: 100.0 kg
- Week 11: 98.0 kg
- Week 22: 96.9 kg

*P = 0.001*
Body Weight
(n = 49 vegan, 50 ADA)
(Missing values returned to baseline)

Week 0
Week 11
Week 22
Week 74

85
90
95
100
105

Weight (kg)

ADA
Vegan

99.3
97.0
96.7
93.3

(-3.7 from baseline)
(-2.6 from baseline)
P=0.36
LDL at Baseline and at 11 and 22 Weeks
Participants with No Changes to Lipid Medications
(n = 39 vegan, 39 ADA)

<table>
<thead>
<tr>
<th>Week</th>
<th>Vegan</th>
<th>ADA</th>
<th>Change</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>115.3</td>
<td>107.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>108.4</td>
<td>104.6</td>
<td>-9.3%</td>
<td>0.02</td>
</tr>
<tr>
<td>22</td>
<td>84.6</td>
<td></td>
<td>-21.2%</td>
<td></td>
</tr>
</tbody>
</table>

P = 0.02
Low Density Lipoprotein
Baseline to 74 Weeks or Last Value before Medication Change
(n = 49 vegan, 49 ADA)

Week 0

Week 74

LDL (mg/dl)

Vegan

ADA

-13%
P = .001
Plasma Triglyceride
Baseline to 74 Weeks or Last Value before Medication Change
(n = 49 vegan, 50 ADA)

Week 0

Week 74

TG (mg/dl)

190
180
170
160
150
140
130
120
110
100

Week 0

Week 74

P = 0.36

Vegan

ADA
Log Urinary Albumin
Baseline to 74 Weeks or Last Available Value
(n = 49 vegan, 50 ADA)

P = .18
Vance

Lost 60 pounds
A1c fell from 9.5 to 5.3
Doctor asked him to stop diabetes medications.
Nancy

Lost 40 pounds
A1c fell from 8.3 to 6.4.
Stopped 1 of 2 diabetes medications.
Arthritis improved dramatically.
Putative Mechanisms

Weight loss
Reduced intramyocellular lipid
Reduced saturated fat intake
Reduced GI
Reduced iron
Weight Loss and A1c Change

Pearson’s correlation for weight loss and A1c change: 0.51, P <0.0001.

Each kg lost was associated with A1c change of -0.12.
Fat Inside Cells Interferes with Insulin’s Action

- Insulin
- Glucose
- Intramyocellular lipid
- Mitochondria

intracellular signaling
**IMCL in Young Adults**

<table>
<thead>
<tr>
<th></th>
<th>Insulin-sensitive</th>
<th>Insulin-resistant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>28</td>
<td>26</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>60</td>
<td>64</td>
</tr>
<tr>
<td>A1c</td>
<td>5.1</td>
<td>5.2</td>
</tr>
</tbody>
</table>

Those with insulin resistance had 80% more IMCL (80% more fat in muscle cells).

Fatty Foods Boost IMCL

Pennington Biomedical Research Center,
Baton Rouge, Louisiana
Fatty Foods Boost IMCL

10 male volunteers, average age 23 years
Average weight: 79 kg
High-fat diet (50% of calories) for 3 days.

↑ intramyocellular lipid (increased fat in muscle cells).
Genes for mitochondrial activity were partially inactivated.

Biliopancreatic Diversion
Biliopancreatic Diversion

Catholic University, Rome

Eight volunteers had biliopancreatic diversion.

IMCL ↓ 87% (87% less fat in muscle cells).
Vegans Have Lower IMCL

Imperial College School of Medicine, London

2 groups, matched for age and weight:

<table>
<thead>
<tr>
<th></th>
<th>25 nonvegetarians</th>
<th>24 vegans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>36 years</td>
<td>35 years</td>
</tr>
<tr>
<td>Weight</td>
<td>68 kg</td>
<td>67 kg</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>162 mg/dl</td>
<td>144 mg/dl</td>
</tr>
<tr>
<td>IMCL (soleus)</td>
<td>16.9 IMCL/Cr</td>
<td>11.7 IMCL/Cr</td>
</tr>
</tbody>
</table>
Steps for Introducing a New Approach

Step 1. Preliminaries: try out recipes

- Spaghetti marinara with wild mushrooms
- Bean burritos with Spanish rice
- Cauliflower and chickpea curry
- Cuban black beans and rice
- Autumn stew with winter squash
- Mushroom stroganoff
- Spinach lasagna
Steps for Introducing a New Approach

Step 1. Preliminaries: try out recipes

Step 2. Take a 3-week “test-drive”
Plant-based diets are effective for glycemic, lipid, and weight control.

Adherence compares favorably with a more conventional diabetes diet.
Acknowledgements:

Joshua Cohen, M.D., George Washington University
David J.A. Jenkins, M.D., Ph.D., University of Toronto
Gabrielle Turner-McGrievy, M.S., R.D, University of North Carolina
Paul Poppen, Ph.D., George Washington University

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