Nuts and Clinical Trials, Mechanisms and Recommendations

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- **Affiliations:** Pennsylvania State University, AHA Nutrition Committee
- **Disclosure:** Dr. Kris-Etherton has no disclosures for this program.

Outline

1. Epidemiologic and clinical trial evidence in support of current dietary recommendations for nuts
2. Mechanisms that account for the cardiometabolic benefits of nuts
3. Dietary recommendations for nuts
4. Summary
WHO - The Global Burden of Disease Study

THE WORLD'S TOP 12 HEALTH PROBLEMS
(Ranked by Disability-Adjusted Life Years (DALYs))

<table>
<thead>
<tr>
<th>Rank</th>
<th>1990</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lower respiratory infection</td>
<td>Lower respiratory infection</td>
</tr>
<tr>
<td>2</td>
<td>Diarrhea</td>
<td>Stroke</td>
</tr>
<tr>
<td>3</td>
<td>Preterm birth</td>
<td>Low back pain</td>
</tr>
<tr>
<td>4</td>
<td>Ischemic heart disease</td>
<td>COPD</td>
</tr>
<tr>
<td>5</td>
<td>Stroke</td>
<td>Diarrhea</td>
</tr>
<tr>
<td>6</td>
<td>COPD</td>
<td>HIV</td>
</tr>
<tr>
<td>7</td>
<td>Malnutrition</td>
<td>COPD</td>
</tr>
<tr>
<td>8</td>
<td>Tuberculosis</td>
<td>Preterm birth</td>
</tr>
<tr>
<td>9</td>
<td>Alcohol</td>
<td>Road injury</td>
</tr>
<tr>
<td>10</td>
<td>Neonatal encephalitis</td>
<td>Major depressive disorders</td>
</tr>
<tr>
<td>11</td>
<td>Major depressive disorders</td>
<td>Neonatal encephalitis</td>
</tr>
<tr>
<td>12</td>
<td>Neonatal encephalitis</td>
<td>Injury</td>
</tr>
</tbody>
</table>

[Rank and rile. GBD 2010 documents major shifts in DALYs and risk factors since 1990, but some doubt the new data. (Cohen, Science, 2012)]

Healthy Dietary Patterns

- 2015 DGAC identified a healthy dietary pattern as:
  - High in vegetables, fruits, whole grains, low-fat dairy, seafood, legumes, and nuts
  - Moderate in alcohol
  - Lower in red and processed meats
  - Low in added sugars (not more than 10% of total energy)
  - Low in refined grains

- The DGAC also recommends that, as part of a healthy dietary pattern:
  - Saturated fat not exceed 10% of total energy (emphasizing substitution of polyunsaturated fats for saturated fats)
  - Limiting sodium intake to not more than 2300 mg per day
  - Calories to meet energy needs and to achieve and maintain ideal body weight

- Associated with more favorable environmental outcomes.

[2015 DGAC: Meeting 7]
**Actions for Individuals and Families/Households**

- Improve food & menu choices, modify recipes, and watch portion sizes.
- Include more vegetables, fruits, whole grains, seafood, nuts, legumes, low/non-fat dairy.
- Reduce red and processed meat, refined grains, added sugars, sodium, and saturated fat. **Substitute SFA with PUFA and replace solid animal fat with vegetable oils and nuts.**


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**Chapter 4: Foods and Nutrients to Increase**

- **Key Recommendations**
  - Choose a variety of **protein foods** which include meat, poultry, seafood, eggs, beans and peas, soy products, and nuts and seeds.
  - Increase the variety and volume of plant foods, such as by choosing whole grains instead of refined grains.
  - Choose foods that provide more potassium, fiber, folate, vitamin A, and vitamin D, which are nutrients of concern in American diets.
  - Choose foods that provide more potassium, fiber, folate, vitamin A, and vitamin D, which are nutrients of concern in American diets.

(USDA, Dietary Guidelines for Americans, 2010)

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**CVD Benefits of Nut & Peanut Consumption**

- Nuts and peanuts are associated with reduced CVD risk.
- They are rich in unsaturated fats, fiber, protein, and antioxidants.
- Regular consumption can lower blood pressure and cholesterol levels.

- CVD risk reduction through moderate nut intake is supported by multiple studies.

- Nuts and peanut consumption is recommended for a healthy diet.
Frequency of Nut Consumption Reduces CHD Risk in a Dose-Response Manner

Results are from four epidemiologic studies.


Table 1. Associations of Nut and Peanut Intake With Total Mortality in the SCCS and Peanut Intake With Total Mortality in the SSSS/AVMS

<table>
<thead>
<tr>
<th>Nut Intake Category</th>
<th>Total Mortality (N=3,527)</th>
<th>No. of Deaths</th>
<th>Adjusted HR (95% CI)</th>
<th>Total Mortality (N=3,527)</th>
<th>No. of Deaths</th>
<th>Adjusted HR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never/Rarely</td>
<td>1.00</td>
<td>1 (Reference)</td>
<td>0.96 (0.90-1.02)</td>
<td>1.00</td>
<td>1 (Reference)</td>
<td>0.76 (0.62-0.94)</td>
</tr>
<tr>
<td>1 Sv/Week</td>
<td>0.87</td>
<td>0.75 (0.63-0.91)</td>
<td></td>
<td>0.87</td>
<td>0.75 (0.63-0.91)</td>
<td></td>
</tr>
<tr>
<td>2 Sv/Week</td>
<td>0.76</td>
<td>0.62 (0.50-0.80)</td>
<td></td>
<td>0.76</td>
<td>0.62 (0.50-0.80)</td>
<td></td>
</tr>
<tr>
<td>3 Sv/Week</td>
<td>0.69</td>
<td>0.57 (0.44-0.75)</td>
<td></td>
<td>0.69</td>
<td>0.57 (0.44-0.75)</td>
<td></td>
</tr>
<tr>
<td>4 Sv/Week</td>
<td>0.63</td>
<td>0.50 (0.38-0.66)</td>
<td></td>
<td>0.63</td>
<td>0.50 (0.38-0.66)</td>
<td></td>
</tr>
<tr>
<td>5 Sv/Week</td>
<td>0.59</td>
<td>0.45 (0.32-0.62)</td>
<td></td>
<td>0.59</td>
<td>0.45 (0.32-0.62)</td>
<td></td>
</tr>
<tr>
<td>P-Trend</td>
<td></td>
<td></td>
<td>0.002</td>
<td></td>
<td></td>
<td>0.002</td>
</tr>
</tbody>
</table>

Pan et al., J Nutr, 2013

Walnut Consumption is Associated with Lower Risk of Type 2 Diabetes in Women

Frequency of Walnut Consumption

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Never/Rarely</th>
<th>&lt; 1 Sv/Week</th>
<th>1 Sv/Week</th>
<th>≥ 2 Sv/Week</th>
<th>P-Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multivariate Model BMI</td>
<td>1.00</td>
<td>0.96</td>
<td>0.87</td>
<td>0.76</td>
<td>0.002</td>
</tr>
</tbody>
</table>

(Walnut Consumption is Associated with Lower Risk of Type 2 Diabetes in Women. Semin Clin Nutr, 2013)

Luu et al, JAMA Intern Med., 2015

(Pan et al., J Nutr, 2013)
Primary Prevention of Cardiovascular Disease with a Mediterranean Diet

Ramón Estruch, M.D., Ph.D., Emilio Ros, M.D., Ph.D., Jordi Salas-Salvadó, M.D., Ph.D., María-Izaskun Covas, D.Pharm., Ph.D., Dolores Corella, D.Pharm., Ph.D., Fernando Arts, M.D., Ph.D., Enrique Gómez-Grau, M.D., Ph.D., Valentina Ruiz-Gutiérrez, M.D., Ph.D., Miguel Fiol, M.D., Ph.D., José Lapetra, M.D., Ph.D., Rosa María Lamuela-Raventós, D.Pharm., Ph.D., Luis Serra-Majem, M.D., Ph.D., Xavier Pintó, M.D., Ph.D., Josep Basset, M.D., Ph.D., Miguel Ángel Muñoz, M.D., Ph.D., José V. Sorli, M.D., Ph.D., José Alfredo Martínez, D.Pharm., M.D., Ph.D., and Miguel Ángel Martínez-González, M.D., Ph.D., for the PREDIMED Study Investigators*

PREDIMED Trial: Design

- Men: 55–80 yr
- Women: 60–80 yr
- High CV risk without CVD
- Type 2 diabetics
- 3+ risk factors

Random

MedDiet + Olive Oil  
N=2500

MedDiet + Nuts  
N=2500

CONTROL GROUP  
N=2500

All free of CVD at baseline

Participants (n = 7447) were randomly assigned to:

- Mediterranean diet supplemented with extra-virgin olive oil (1 L/week)
- Mediterranean diet supplemented with mixed nuts (30 g/d; 15 g walnuts; 7.5 g almonds; 7.5 g hazelnuts)
- Control diet (advice to reduce dietary fat)

Participants received quarterly individual and group education sessions and free extra-virgin olive oil or mixed nuts.

The primary end point was the rate of major cardiovascular events (myocardial infarction, stroke, or death from cardiovascular causes). The trial was stopped after a median follow-up of 4.8 years rather than continuing for 6 years, as planned.
Intake of Energy and Nutrients at the End of the Trial by Study Group

<table>
<thead>
<tr>
<th>Variable</th>
<th>MedDiet + EVOO</th>
<th>MedDiet + Nuts</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy, kcal</td>
<td>2172</td>
<td>2229</td>
<td>1960</td>
</tr>
<tr>
<td>CHO, % E</td>
<td>40</td>
<td>40</td>
<td>44</td>
</tr>
<tr>
<td>Fat, % E</td>
<td>41</td>
<td>42</td>
<td>37</td>
</tr>
<tr>
<td>SFA, % E</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>MUFA, % E</td>
<td>22</td>
<td>21</td>
<td>19</td>
</tr>
<tr>
<td>PUFA, % E</td>
<td>6</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Linoleic acid, g/d</td>
<td>12</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>ALA, g/d</td>
<td>1.3</td>
<td>1.5</td>
<td>1.3</td>
</tr>
<tr>
<td>Marine n-3 FA, g/d</td>
<td>0.9</td>
<td>0.8</td>
<td>0.7</td>
</tr>
</tbody>
</table>


PREDIMED Trial:
The Incidence of Acute Myocardial Infarction, Stroke, and Death from Cardiovascular Causes by Treatment

Kaplan-Meier Estimates of Incidence of the Significant Separate Component (Stroke) of the Primary Endpoint

(Figure S6. (Estruch et al., N Engl J Med, 2013))
Recent Evidence from PREDIMED: Further Benefits of Olive Oil and Nuts

- Both Med diet groups
  - Decreased diastolic BP versus the control. (Toledo et al, *BMC Med*, 2013)
  - Improved cognition measured by MMSE and CDT scores. (Martínez-Lapiscina et al, *J Neurol Neurosurg Psychiatry*, 2013)
  - Decreased systolic & diastolic blood pressure, total cholesterol and LDL-C, fasting blood glucose, and inflammatory biomarkers. (Domenich et al, *Hypertension*, 2014)

Cumulative Incidence of Diabetes During 5.5 Years

- Benefits of nuts
  - Increased nut consumption reduced risk of mortality (HR 0.37; 95% CI 0.22 to 0.66). (Gausch-Ferrer et al, *BMC Med*, 2014)
  - Decreased progression of internal carotid intima-media thickness and plaque. (Sala-Vila et al, *Arterioscler Thromb Vasc Biol*, 2014)

- Benefits of extravirgin olive oil
  - Decreased risk of atrial fibrillation versus the control group. Nuts had no effect. (Martínez-González et al, *Circulation*, 2014)
**Effect of Nut-Enriched Diets on Serum Lipids and Lipoproteins by Level of Nut Intake**

A Pooled Analysis of 25 Feeding Trials (1284 Data Points)

![Graph showing percent change in serum lipids and lipoproteins by level of nut intake.](image)

(Sabaté et al, Arch Intern Med, 2010)

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**Effects of Daily Almond Consumption on Cardiometabolic Risk Factors in Individuals with Elevated LDL-Cholesterol: Lipids and lipoproteins and body composition**

(Berryman et al, J Am Heart Assoc, 2015)

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**Experimental Design**

**Screening Visit**
- Measures:
  - Ht/wt
  - Blood pressure
  - Blood draw (CBC, Chem 24)
- Qualifications:
  - Male/ Female
  - Age: 30-65
  - BMI: 20-35
  - LDL-C: 50th-95th percentile
  - Non-smokers
  - Not taking cholesterol-lowering medications/ supplements

**Clinic Visit:** Blood draw, blood pressure, DXA, waist circumference
Diet Design: Sample Menu

Step 1 diet + almonds OR Step 1 diet without almonds (control)

<table>
<thead>
<tr>
<th>Breakfast</th>
<th>Snack</th>
<th>Lunch</th>
<th>Dinner</th>
</tr>
</thead>
<tbody>
<tr>
<td>2% milk</td>
<td>1.5 oz. almonds OR 106 g banana muffin</td>
<td>White bread Deli turkey Provolone cheese Mayonnaise Pretzels Yogurt Pear</td>
<td>Chicken parmesan Broccoli Dinner roll Margarine</td>
</tr>
<tr>
<td>Oatmeal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apple juice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>English muffin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blueberries</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Margarine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5 oz. almonds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>106 g banana muffin</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Almonds Improve Lipids and Lipoproteins

Different lowercase letters within variables indicate treatment differences. *Significantly different than baseline, P < 0.05

Almonds do not Increase Non-HDL-C Subparticles

Different lowercase letters within variables indicate treatment differences. *Significantly different than baseline, P < 0.05
A total of 190 patients treated with statins after ACS were enrolled in the study. All the patients were followed prospectively for a maximum period of 70 months or until the occurrence of one of the following events: cardiac death, non-fatal myocardial infarction, unstable angina requiring unplanned coronary revascularization, or ischemic stroke. (Nguyen et al, Circ, 2014)

Different lowercase letters within variables indicate treatment differences, P < 0.05
*Significantly different than baseline, P < 0.05

Almonds Reduced Abdominal Fat and Lean Mass

Different lowercase letters within variables indicate treatment differences, P < 0.05
*Significantly different than baseline, P < 0.05
Conclusions

- Consumption of almonds (1.5 oz./d), in a cholesterol-lowering diet, provides further total and LDL-cholesterol reductions
- Almond consumption improves lipid and lipoprotein profile which is predictive of cardiovascular disease risk
- Almonds have a beneficial effect on regional body composition, decreasing both abdominal and leg adiposity
Nutrient Profiles of Experimental Diets:

<table>
<thead>
<tr>
<th>% of calories as:</th>
<th>Average American Diet</th>
<th>Walnuts + Walnut Oil</th>
<th>Walnuts, Walnut Oil, + Flax Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrate</td>
<td>50</td>
<td>47</td>
<td>46</td>
</tr>
<tr>
<td>Protein</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Total Fat</td>
<td>35</td>
<td>37</td>
<td>38</td>
</tr>
<tr>
<td>▪ Saturated</td>
<td>13</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>▪ Monounsaturated</td>
<td>13</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>▪ Polyunsaturated</td>
<td>9</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>Linoleic acid (n-6)</td>
<td>8</td>
<td>13</td>
<td>11</td>
</tr>
<tr>
<td>α-Linolenic acid (n-3)</td>
<td>1</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Cholesterol (mg/d)</td>
<td>311</td>
<td>304</td>
<td>305</td>
</tr>
</tbody>
</table>

One meal consumed on-site each day, all other meals and snacks were packed for take-out.

Study Design

Randomized Cross-Over Controlled Feeding

<table>
<thead>
<tr>
<th>6 weeks</th>
<th>2 weeks</th>
<th>6 weeks</th>
<th>2 weeks</th>
<th>6 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Diet</td>
<td>Walnuts + oil</td>
<td>Walnuts + oil + flax</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All meals prepared in a metabolic kitchen – body weight was maintained. Each experimental diet included the same amount of walnuts (37g) and walnut oil (15g). For the higher dose ALA diet, 19 g/d of flax oil was added.


Effects of Walnuts and Flaxseed on CVD Risk Factors

<table>
<thead>
<tr>
<th></th>
<th>BP (SBP/DBP)</th>
<th>LDL-C</th>
<th>FMD (Endothelial Function)</th>
<th>CRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walnut &amp; Flax</td>
<td>-3 / -3*</td>
<td>-14%*</td>
<td>+ 34%*</td>
<td>-75%*</td>
</tr>
<tr>
<td>Diet1,2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walnut Diet</td>
<td>-3 / -3*</td>
<td>-14%*</td>
<td>+ 10%</td>
<td>-45%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = significant change vs. control diet

(West et al, J Nutr, 2004; West et al, J Am Coll Nutr, 2010)
A Walnut Diet Improves Endothelial Function in Hypercholesterolemic Subjects

Beneficial effects on cardiovascular health beyond cholesterol-lowering

A Walnut Diet Improves Endothelial Function in Hypercholesterolemic Subjects

Acute Consumption of Whole Walnuts (85 g) Increases Cholesterol Efflux

Kaplan–Meier Curves and Hazard Ratios for Cardiovascular Events, According to Quartile of Cholesterol Efflux Capacity
Ambulatory Blood Pressure

- Allows BP readings to be taken across a 24-hour period.
- Using ambulatory blood pressure monitoring to rule out white-coat hypertension prevents patients from being prescribed unnecessary antihypertensive medications.
- Ambulatory blood pressure monitoring also allows measurement of nocturnal BP, an increasingly important prognostic parameter for cardiovascular disease.

A non-dipping pattern and nocturnal hypertension are strongly associated with increased cardiovascular morbidity and mortality.


**Note:** The graph shows a comparison of BP differences with confidence intervals (CI). The shaded areas represent 95% CIs, and significant differences are indicated by asterisks (*) where the CIs do not overlap.
**Pistachios Decrease TC and LDL-C**

- Lower Fat (25% en)
- 1 Serving/d of Pistachios (30% en)
- 2 Serving/d of Pistachios (34% en)

![Graph showing change in TC, LDL, and HDL levels with different diets.](Gebauer et al., *Am J Clin Nutr*, 2008)

**Pistachios Increased the Levels of Functional HDL Particles**

![Graph showing ABCA1 Efflux and Global Efflux with and without Pistachios.](Holligan et al., *Br J Nutr*, 2014)

2 Serving/d of Pistachios Increased Cholesterol Efflux Capacity Versus 1 Serving/d of Pistachios in Low CRP Individuals

**American Heart Association 2020 Goals (Dietary)**

<table>
<thead>
<tr>
<th>Primary</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruits &amp; Vegetables</td>
<td>≥ 4.5 cups/day</td>
</tr>
<tr>
<td>Fish</td>
<td>≥ two 3.5 oz. servings/week (preferably oily fish)</td>
</tr>
<tr>
<td>Fiber-Rich Whole Grains</td>
<td>≥ 11 g of fiber/10 g of CHO; three 1 oz. equivalent servings per day</td>
</tr>
<tr>
<td>Sodium</td>
<td>&lt; 1500 mg/day</td>
</tr>
<tr>
<td>Sugar-Sweetened Beverages</td>
<td>≤ 450 kcal (36 oz./week)</td>
</tr>
<tr>
<td>Nuts, Legumes, &amp; Seeds</td>
<td>≥ 4 servings/week</td>
</tr>
<tr>
<td>Processed Meats</td>
<td>none or ≤ 2 servings/week</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>≤ 7% of total energy intake</td>
</tr>
</tbody>
</table>

(Lloyd-Jones et al., *Circulation*, 2010)
There are many dietary recommendations for nuts. Epidemiologic and clinical trial evidence supports dietary recommendations for nuts. Multiple mechanisms account for the cardiometabolic benefits of nuts, including benefits on chronic diseases such as CVD, diabetes, metabolic syndrome and biomarkers for disease risk, i.e., lipids/lipoproteins, remnant lipoproteins, cholesterol efflux, blood pressure, visceral adiposity, among others.
**Nurses Health Study**

**Nut Consumption versus BMI**

(From et al., BMJ, 1998)

**Physicians Health Study (N=21,454)**

**Average Frequency of Dietary Nut Intake**

(Abert et al., Arch intern Med, 2002)

**Level 2 Clinical Evidence**
### Nuts and Weight Change

<table>
<thead>
<tr>
<th>Nut</th>
<th>Subjects</th>
<th>Duration (months)</th>
<th>Weight Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almond</td>
<td>Abby, 1994</td>
<td>16</td>
<td>0.75 NS</td>
</tr>
<tr>
<td>Macadamia</td>
<td>Spiller, 2003</td>
<td>48</td>
<td>1 NS</td>
</tr>
<tr>
<td></td>
<td>Hyman, 2002</td>
<td>22</td>
<td>1.5 NS</td>
</tr>
<tr>
<td>Almond</td>
<td>Jenkins, 2002</td>
<td>27</td>
<td>1 L</td>
</tr>
<tr>
<td>Almond</td>
<td>Lovejoy, 2002</td>
<td>20</td>
<td>1 &lt;=1Kg</td>
</tr>
<tr>
<td>Almond</td>
<td>Spiller, 2003</td>
<td>38</td>
<td>1 NS</td>
</tr>
<tr>
<td>Almond</td>
<td>Fraser, 2002</td>
<td>81</td>
<td>6 NS</td>
</tr>
<tr>
<td>Almond</td>
<td>Hyson, 2002</td>
<td>22</td>
<td>1.5 NS</td>
</tr>
<tr>
<td>Almond</td>
<td>Jenkins, 2002</td>
<td>27</td>
<td>1 L</td>
</tr>
<tr>
<td>Almond</td>
<td>Hyson, 2002</td>
<td>22</td>
<td>1.5 NS</td>
</tr>
<tr>
<td>Almond</td>
<td>Jenkins, 2002</td>
<td>27</td>
<td>1 L</td>
</tr>
<tr>
<td>Almond</td>
<td>Holley, 2007</td>
<td>20</td>
<td>2.5 NS</td>
</tr>
<tr>
<td>Almond</td>
<td>Curb, 2000</td>
<td>65</td>
<td>6 L</td>
</tr>
<tr>
<td>Almond</td>
<td>Morgan, 2001</td>
<td>19</td>
<td>2 NS</td>
</tr>
<tr>
<td>Almond</td>
<td>Rajaram, 2001</td>
<td>23</td>
<td>1 L</td>
</tr>
<tr>
<td>Almond</td>
<td>Kris-Etherton, 1999</td>
<td>22</td>
<td>0.75 NS</td>
</tr>
<tr>
<td>Almond</td>
<td>Alperi, 2002</td>
<td>35</td>
<td>4.75 NS</td>
</tr>
<tr>
<td>Pecan</td>
<td>Morgan, 2001</td>
<td>19</td>
<td>2 NS</td>
</tr>
<tr>
<td>Pecan</td>
<td>Rajaram, 2001</td>
<td>23</td>
<td>1 L</td>
</tr>
<tr>
<td>Pecan</td>
<td>Alperi, 2002</td>
<td>35</td>
<td>4.75 NS</td>
</tr>
<tr>
<td>Pecan</td>
<td>Morgan, 2001</td>
<td>19</td>
<td>2 NS</td>
</tr>
<tr>
<td>Pecan</td>
<td>Rajaram, 2001</td>
<td>23</td>
<td>1 L</td>
</tr>
<tr>
<td>Pistachio</td>
<td>Edwards, 1999</td>
<td>10</td>
<td>0.75 NS</td>
</tr>
<tr>
<td>Walnut</td>
<td>Almario, 2001</td>
<td>18</td>
<td>1.5 NS</td>
</tr>
<tr>
<td>Walnut</td>
<td>Sabate, 1993</td>
<td>80</td>
<td>1 L</td>
</tr>
<tr>
<td>Walnut</td>
<td>Sabate, 1993</td>
<td>80</td>
<td>1 L</td>
</tr>
<tr>
<td>Walnut</td>
<td>Sabate, 2005</td>
<td>80</td>
<td>6 +0.4Kg</td>
</tr>
<tr>
<td>Walnut</td>
<td>Sabate, 2005</td>
<td>80</td>
<td>6 +0.4Kg</td>
</tr>
</tbody>
</table>

### Level 3

**Mechanistic Evidence**

### Mechanisms

- Appetite
- Energy yield
- Energy Expenditure
Appetite

Appetitive Effects of Nuts

- **Suppress Hunger:**
  - Eating initiation
- **Suppress Desire to eat:**
  - Eating in the absence of hunger
- **Fullness:**
  - Meal size

Healthy Snacks

Can the right snack have an impact on satiety and reduce energy intake?

| A (28g almonds) | B (42g almonds) |
Factors Contributing to Satiety

- Energy
- Fatty Acids
- Rheology
- Macronutrient Profile
- Fiber
- Cognition
The **Satiety** value of nuts appears to stem from the synergy of their components.

### Dietary Compensation

<table>
<thead>
<tr>
<th>Study</th>
<th>Nut</th>
<th>% Compensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fraser et al., 2002</td>
<td>Almonds</td>
<td>54%, 75%</td>
</tr>
<tr>
<td>Lovejoy et al., 2002</td>
<td>Almonds</td>
<td>63%</td>
</tr>
<tr>
<td>Hollis &amp; Mattes</td>
<td>Almonds</td>
<td>76%</td>
</tr>
<tr>
<td>Curb et al., 1992</td>
<td>Macadamia</td>
<td>58%, 113%</td>
</tr>
<tr>
<td>Kirkmeyer &amp; Mattes, 2000</td>
<td>Peanuts</td>
<td>104%</td>
</tr>
<tr>
<td>Alper &amp; Mattes, 2001</td>
<td>Peanuts</td>
<td>66%</td>
</tr>
<tr>
<td>Almarino et al., 2001</td>
<td>Walnuts</td>
<td>96%</td>
</tr>
<tr>
<td>Abbey et al., 1994</td>
<td>Walnuts</td>
<td>55%</td>
</tr>
<tr>
<td>Tey et al., 2011</td>
<td>Hazelnuts</td>
<td>100%</td>
</tr>
</tbody>
</table>

- **100** kcal Daily Load
- **-70** kcal – Dietary Compensation
- **30** kcal
Figure 1 – Median REE for lean and overweight participants at baseline and after 8 weeks of peanut oil ingestion. L = lean, O = overweight, M = male, F = female, T = total subjects (male and female). Medians with different letters are significantly different in the same group (p<0.01).
Absorption Efficiency

Inefficient Absorption

- 100 kcal Daily Load
  - 70 kcal – Dietary Compensation
  - 30 kcal
  - 10 kcal – Increased RMR
  - 20 kcal

Levine and Silvas, 1980
Haddad and Sabate, 2000
Zemaitis and Sabate, 2001
Ellis et. al., 2004

Peanuts = 95% dietary fat for 6 d
Pecans = 31% dietary fat for 4 wk
Almonds = 40% dietary fat for 4 wk
Almonds approx 30-45% dietary fat for 3 d
Inefficient Absorption

7-9 day controlled diet with 70 g of peanuts/ peanut butter/ peanut flour/ peanut oil

% Fecal Fat

Control
Treatment

(Peanuts, Peanut Butter, Peanut Oil, Peanut Flour)

(Traoret et al, Int J Obes (Lond), 2008)

Almond Particle Size after Mastication

By Number of Chews


(Cassady et al, Am J Clin Nutr, 2009)
Fecal Fat and Energy Lost
By Number of Chews

![Graph showing energy and fat by number of chews](Cassady et al., Am J Clin Nutr, 2009)

Nuts and Energy Balance

<table>
<thead>
<tr>
<th>Component of Energy Balance</th>
<th>% Almond Energy Dissipated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted body weight gain (kg)</td>
<td>3.1</td>
</tr>
<tr>
<td>Actual body weight gained (kg)</td>
<td>0</td>
</tr>
<tr>
<td>Dietary compensation (KJ)</td>
<td>802</td>
</tr>
<tr>
<td>Fecal excretion (KJ)</td>
<td>84</td>
</tr>
<tr>
<td>Energy Expenditure (KJ)</td>
<td></td>
</tr>
<tr>
<td>REE</td>
<td>184</td>
</tr>
<tr>
<td>TEF</td>
<td>13</td>
</tr>
<tr>
<td>Physical Activity</td>
<td>-79</td>
</tr>
<tr>
<td>Total Energy (DLW)</td>
<td>180</td>
</tr>
</tbody>
</table>

Dissipated: 74%

Total Energy Explained: 95%
Change of Palatability

- **Time**: Week 2, Week 4, Week 6, Week 8, Week 10, Week 12
- **Palatability** (0=did not like at all, 10=liked extremely)
- **N=51**
- **Single**
- **Variety**
- **All**

Almonds
- **Baseline**
- **Post-Diet**

Control
- **Baseline**
- **Post-Diet**

No Oral Stimulation

Insula Activation

- **T-stat**
- **Baseline**
- **Post**

Almond  | Control
**Study Design**

- Four-week randomized, controlled, parallel-arm study
- Healthy adults with increased risk for T2DM
  - 18 – 60 y-o, non-diabetic
  - Overweight (BMI>25) and/or family history
- Five study groups:
  - Control (CL), Meal (BF & LN), Snack (MS & AS)

**Almond Consumption and Energy Intake**

(Tan and Mattes, Eur J Clin Nutr, 2013)

**Almond Consumption and Body Weight**

(Tan and Mattes, Eur J Clin Nutr, 2013)
Summary

- Epidemiological, Clinical and mechanistic data indicate nuts pose limited threat to positive energy balance
- Nuts have strong satiety properties and elicit strong compensatory dietary compensation
- Energy absorption from nuts is less than predicted
- Nuts are associated with elevated resting energy expenditure
- Nuts may be a useful snack option

Nuts and Healthy Diet

Sharon Palmer, RDN

Disclosure: Sharon provides consultant services for a select group of organizations, including American Pistachio Growers, Daisy Brand Cottage Cheese, SOYJOY, and Tomato Product Wellness Council.
What Are Tree Nuts?

Dry fruits with one seed in which the ovary wall becomes hard at maturity:

- Almonds
- Walnuts
- Cashews
- Pecans
- Pistachios
- Hazelnuts
- Brazil nuts
- Macadamia nuts
- Pine nuts

Nuts and Nutritional Profile

(Nutrient Content of Tree Nuts (1 oz.)

(U.S. Department of Agriculture, National Nutrient Database, 2015)

(Nutritional Profile of Tree Nuts (1 oz.)

(U.S. Department of Agriculture, National Nutrient Database, 2015)
Nuts and Nutritional Profile

<table>
<thead>
<tr>
<th>Nut (1 oz.)</th>
<th>Calories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almonds</td>
<td>169</td>
</tr>
<tr>
<td>Walnuts</td>
<td>185</td>
</tr>
<tr>
<td>Cashews</td>
<td>155</td>
</tr>
<tr>
<td>Pecans</td>
<td>199</td>
</tr>
<tr>
<td>Pistachios</td>
<td>161</td>
</tr>
<tr>
<td>Hazelnuts</td>
<td>181</td>
</tr>
<tr>
<td>Brazil nuts</td>
<td>185</td>
</tr>
<tr>
<td>Macadamia nuts</td>
<td>203</td>
</tr>
<tr>
<td>Pine nuts</td>
<td>190</td>
</tr>
</tbody>
</table>

(USDA, National Nutrient Database, 2015)

Nutritional Attributes for Nuts

- Nutrient Dense
- Healthy Fats
- Protein
- Fiber
- Vitamins and Minerals
- Phytochemicals

Nutrient Dense

Nature’s unique treasure: packed with healthy fats, fiber, protein, vitamins, minerals, and phytochemicals in a small serving.
Healthy Fats

- High total fat content: 46 – 76% fat
- Ample unsaturated fats: monounsaturated and polyunsaturated fats
- Low in saturated fat (4-16%)
- Helps lower LDL cholesterol; reduce risk of cardiovascular disease
- Omega-3 fatty acids (ALA) also present in walnuts—highest content in all edible plants

(Ros, Nutrients, 2010)

Protein

- Good plant-based high quality protein source (about 25% of energy)
- Some richer in protein: almonds, pistachios 6 grams per ounce
- High in L-Arginine: amino acid converted to nitric oxide in the body; helps keep blood vessels elastic, thereby reducing the risk of atherosclerosis, found in walnuts, almonds, cashews, and pistachios

(Ros, Nutrients, 2010)

Fiber

- Fiber (4-11 grams per 100 grams); 5-10% DV for fiber in one standard serving; primarily insoluble fiber
- Plant sterols and stanols, components of plant membranes resemble chemical structure of cholesterol; only obtained through plant sources; lower blood cholesterol by blocking its absorption by competing for cholesterol in gut

(Ros, Nutrients, 2010; International Food Information Council Foundation, 2014)
Vitamins and Minerals

Range of micronutrients, depending on nut:

- vitamins B6, E (important source; almonds, hazelnuts) and K, riboflavin, thiamin
- copper, manganese, magnesium, iron, selenium, zinc, calcium, phosphorus

(USDA, National Nutrient Database, 2015)

Phytochemicals

- Bioactive compounds in plants, possess antioxidant and anti-inflammatory activity
- Concentrated in nuts; high in antioxidant capacity; i.e. walnuts and pistachios rank high
- Range:
  - flavonoids (quercetin, kaempferol, rutin)
  - phenolic compounds (proanthocyanidins)
  - isoflavonoids
  - carotenoids (lutein, zeaxanthin in pistachios)
  - stilbenes (resveratrol in pistachios)

(Ros. Nutrients, 2010)

Recommended Serving

- Research supports: 1 – 1 ½ ounces per day, about one handful
- FDA Qualified Health Claim
  “Scientific evidence suggests but does not prove that eating 1.5 ounces per day of most nuts, as part of a diet low in saturated fat and cholesterol, may reduce the risk of heart disease.” (US FDA, 2014)
- Nuts and seeds recommended 4 – 7 ounces per week by DGAC 2015
RDs Can Help!
Adding a daily dose of nuts is good nutrition advice:

• For all age groups, from young to old
• Perfect easy, whole foods snack
• No fuss, preparation, minimal packaging
• Great for packing away in lunchboxes, backpacks, and purses
• Healthy plant-based protein source

RDs Can Help!
Adding a daily dose of nuts is good nutrition advice:

• Health benefits, such as CVD, weight management, and blood glucose control
• Nutrient-rich eating
• Fits in many meal plans, from gluten-free to vegetarian
• Nuts are healthy indulgence, they make everything feel and taste better: salads, yogurts, cereals, sandwiches, baked goods, and beyond

Tips for Boosting Nuts

Find nuts you like and stock them on hand
Maintain freshness by freezing if you won’t use quickly
Portion out one-ounce servings for work, on-the-go, and lunchboxes
Use nuts in baked goods: cookies, muffins, breads, pancakes
Sprinkle nuts on morning cereal
Tips for Boosting Nuts

- Stir nuts into stir-fries
- Toss nuts into salads for crunch and nutrition
- Make homestyle trail mixes with your favorite nuts and dried fruits
- Enjoy nuts sprinkled over yogurt or cottage cheese and fruit
- Use nut butters as a spread, in baking, in sauces and on sandwiches

Getting Nutty on the Menu

1. Breakfast
2. Lunch
3. Dinner
4. Snacks

Breakfast

- Add chopped nuts to breakfast cereal, such as oatmeal, porridge, granola, or cold cereal
- Add chopped nuts to quick breads, such as pecan pancakes, walnut waffles, blueberry hazelnut muffins, or pistachio orange biscuits
- Sprinkle nuts, such as almonds, pistachios or brazil nuts over Greek yogurt with fruit for an easy breakfast
- Spread nut butter, such as almond, walnut, or cashew butter over toast, bagels, or English muffins
Lunch

- Use nut butter, such as almond or cashew butter, as a spread on sandwiches instead of margarine or mayo; even savory sandwiches!
- Toss nuts into salads, such as romaine salad with toasted walnuts, kale salad with almonds, or 3-bean salad with pine nuts.
- Make a simple meal of cottage cheese, seasonal fruit and nuts, such as pistachios, almonds, macadamia nuts and pecans.
- Enjoy an Asian vegetable stir-fry with a sprinkling of nuts, such as almonds.

Dinner

- Add nut butter to savory sauces, such as curry, mole, or Thai sauce.
- Sprinkle nuts, such as pistachios, macadamia, walnuts, or almonds into sautéed vegetables, such as spinach, asparagus or Brussels sprouts, as a side dish.
- Top lean proteins with herbs and chopped nuts, such as pine nuts, hazelnuts, cashews, or pistachios and roast.
- Whiz up a pesto sauce with basil, garlic, EVOO, and nuts, such as almonds, pine nuts, pistachios or walnuts.
- Mix finely diced nuts into bread crumb toppings for casseroles, such as macaroni and cheese, broccoli cheese, or green bean casserole for a nutritious crunch.

Dinner

- Press chopped nuts, such as walnuts, pecans and hazelnuts into veggie-burgers or nut-loafs as a meat alternative.
- Toss cooked whole grain pasta with tomatoes, EVOO, garlic and nuts, such as pine nuts, pistachios, and walnuts.
- Stir chopped nuts, such as almonds, pine nuts, and Brazil nuts into whole grain side-dishes, such as rice pilaf, couscous, and farro.
- Soak cashews overnight and blend into a cashew cream for cooking.
Snacks

- Dip apples in nut butter and top with coconut flakes and dark chocolate chips/raisins
- Serve vegetable crudité with nut butter
- Roast raw nuts, such as cashews, almonds or walnuts in the oven with EVOO, rosemary, sea salt and cayenne pepper
- Sprinkle chopped nuts, such as pistachios, hazelnuts, or macadamia nuts on top of plain non-fat Greek yogurt with berries
- Add nuts such as almonds, hazelnuts, cashews or walnuts to smoothies with fruit, milk and greens

Credit Claiming

You must complete a brief evaluation of the program in order to obtain your certificate. The evaluation will be available for 3 months; you do not have to complete it today.

Credit Claiming Instructions:

1. Go to www.CE.TodaysDietitian.com/TreeNuts OR Log in to www.CE.TodaysDietitian.com and go to My Account → My Activities → Courses (in Progress) and click on the webinar title.
2. Click “Continue” on the webinar description page. Note: You must be logged-in to see the “Continue” button.
3. Select the Evaluation icon to complete and submit the evaluation.
4. Download and print your certificate.

Please Note: If you access the Evaluation between 3-4 pm ET on 3-19 you may experience a slow connection due to a high volume of users.