**Dose-Related Effects of Pistachios on Emerging CVD Risk Factors in Moderately Hypercholesterolemic Individuals**

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**Introduction**

Pistachios are a source of several cardioprotective, bioactive components. They have a unique nutrient and fatty acid profile; they are low in saturated fat, high in unsaturated fats and antioxidants, and are a good source of plant sterols¹. Several emerging markers have been shown to better predict CVD risk before clinical presentation of the disease. These markers may be used along with established risk factors to determine the efficacy of a diet intervention. We chose to characterize the effects of pistachio inclusion in the diet on LDL and HDL subclasses, and levels of Lipoprotein (a). Small-dense LDL (sdLDL) has been associated with increased risk of coronary artery disease and is highly atherogenic due mainly to the ease of its entering the arterial wall and its increased susceptibility to oxidation. HDL is highly heterogeneous and its subclasses are differentially associated with CVD risk. Results from the Framingham Offspring Study showed that low apo A-I and apo A-II HDL levels are stronger predictors of CHD risk than HDL-C alone². These more mature HDL subclasses are able to participate in reverse cholesterol transport and promote atheroregression and reduce CVD risk. An elevated Lipoprotein (a) also is an independent risk factor for CVD events as it can enter the arterial intima and promote inflammation, thrombosis and foam cell formation. Determination of the levels of these lipoprotein subclasses better characterizes CVD risk. Evidence of mediating effects of the bioactives in pistachios on these emerging risk factors would lend support for their inclusion in a heart-healthy, cholesterol-lowering diet.

**Hypothesis**

Investigation of emerging CVD risk factors will provide a more in-depth measure of the cardiometabolic changes associated with inclusion of pistachios in a heart-healthy, cholesterol-lowering diet.

**Methods**

N = 28
18 Women, 10 Men
39 - 61 yrs
LDL-C ≥ 110 mg/dl

3-period, cross-over, controlled feeding study

**Results**

Table 1: Baseline characteristics of participants

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean ± SEM</th>
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<tbody>
<tr>
<td>Age (yr)</td>
<td>48 ± 1.5</td>
</tr>
<tr>
<td>Body Mass Index (kg/m²)</td>
<td>26.5 ± 0.7</td>
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<tr>
<td>Total cholesterol (mg/dl)</td>
<td>209.8 ± 4.7</td>
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<tr>
<td>LDL-C (mg/dl)</td>
<td>133.6 ± 4.3</td>
</tr>
<tr>
<td>HDL-C (mg/dl)</td>
<td>57.9 ± 2.9</td>
</tr>
<tr>
<td>Triglycerides (mg/dl)</td>
<td>103.1 ± 7.6</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>111.9 ± 2.1</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>69.5 ± 1.1</td>
</tr>
</tbody>
</table>

- Participants were randomized to 1 of 3 cholesterol-lowering diets for 4 weeks: Control diet (the Step I diet); 1PD (Step I diet with 1.5 oz pistachios/day); 2PD (Step I diet with 3.0 oz pistachios/day).
- 2-week compliance breaks between diet periods.
- Blood samples taken on 2 consecutive days at the end of each diet period.

**Figure 2:** Group means and 95% Confidence limits. Different letters indicate significant between diet differences (P < 0.05).

**Discussion**

We previously found similar, significant decreases in LDL-C for both the 1PD (-9%) and 2PD (-12%) diets versus the CON (P < 0.05)³. Here we report significant differences (P < 0.05) in small-dense LDL levels (sdLDL) between the 2PD (43.98 ± 1.71 mg/dl) and the CON (44.06 ± 2.50 mg/dl), and between the 2PD and the 1PD diet (42.37 ± 3.35 mg/dl), with no significant difference between the 1PD and the CON. These differences in sdLDL are important since this is a strong predictor of CVD risk. Lower levels of the highly atherogenic sdLDL may decrease the rate of atherosclerosis as these particles are more prone to oxidation. Previous results also showed no effect due to diet on HDL-C levels³. However, current results show a trend towards a significant effect (P = 0.057) on apo A-II HDL levels, with numerically increased levels in the 2PD group over the 1PD and the CON groups. This trend indicates higher levels of cholesterol-rich apo A-II HDL particles, after pistachio inclusion, that may have participated in reverse cholesterol transport and promoted atheroregression. We found no significant effect due to diet for other HDL subclasses (pre β-, a-α, a-β), or for Lipoprotein (a). Our results provide new information about the role of bioactives in pistachios that affect these emerging CVD risk markers.

**Conclusion**

Inclusion of 1.5 – 3.0 oz of pistachios per day as part of a heart-healthy, cholesterol-lowering diet may decrease small-dense LDL levels and provide increased protection against CVD risk.

**References**


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