Replacing Fats and Sweets With Vegetables and Fruits—A Question of Cost

Adam Drewnowski, PhD, Nicole Darmon, PhD, and André Briend, PhD

There is solid evidence that high fruit and vegetable consumption plays a major role in lowering risk of heart disease and type 2 diabetes. A “prudent” dietary pattern characterized by high intake of vegetables, fruits, whole grains, poultry, and fish has been associated with a lower risk of coronary heart disease and with better health status overall.

In contrast, consumption of sugar-sweetened beverages, corn syrup, potatoes, and refined grains has been linked to a higher risk of heart disease and type 2 diabetes. Western dietary patterns, characterized by high consumption of processed meats, fried foods, sweets, and desserts, fail to protect against disease risk. Excess consumption of energy-dense snacks, fast foods, and soft drinks has been linked to higher rates of overweight. A World Health Organization report on diet, nutrition, and prevention of overweight has been linked to higher rates of overweight. A World Health Organization report on diet, nutrition, and prevention of overweight has been linked to higher rates of overweight.

Food Costs and Diet Costs

Dietary intakes (in grams/day) were obtained in the Val-de-Marne dietary survey, conducted in 1988–1989, based on a 2-stage cluster-design sampling procedure. Of 849 families contacted, 527 took part in the study (62% response rate). The analyses reported in this article were based on dietary intake data for 837 adults (361 men and 476 women). Mean age was 42.5 years for men and 42.8 years for women. Details of the study have been published previously.

Analyses of dietary trends in France indicate that the major dietary changes occurred between 1950 and 1985. As fewer changes have occurred since, the Val-de-Marne data are regarded as representative of the current eating habits in France.

Diets high in fats and sweets represent a low-cost option to the consumer, whereas the recommended “prudent” diets cost more. (Am J Public Health. 2004;94:1555–1559)

Objectives. We examined the association between diet quality and estimated diet costs.

Methods. Freely chosen diets of 837 French adults were assessed by a dietary history method. Mean national food prices for 57 foods were used to estimate diet costs.

Results. Diets high in fat, sugar, and grains were associated with lower diet costs after adjustment for energy intakes, gender, and age. For most levels of energy intake, each additional 100 g of fats and sweets was associated with a €0.05–0.40 per day reduction in diet costs. In contrast, each additional 100 g of fruit and vegetables was associated with a €0.18–0.29 per day increase in diet costs.

Conclusions. Diets high in fats and sweets represent a low-cost option to the consumer, whereas the recommended “prudent” diets cost more.
Statistical Analyses

Multivariate regression analyses served to test the relationship between diet composition and diet cost. The standard multivariate method used energy intakes (megajoules per day [MJ/day]) and nutrient intakes (grams per day [g/day]) as terms in a multiple regression model, with diet cost (€/day) as the dependent variable and adjustment for age and gender.

Participants were stratified by quintiles of energy intake (MJ/day) or as percentage energy (% energy), and the relationship between dietary variables and diet cost was tested with 1-way analyses of variance. Participants also were stratified by quintiles of energy intake (MJ/day) to examine the relationship between diet composition and diet cost at each level of intake in a regression model. Analyses were performed with SPSS version 10.1 (SPSS Inc; Chicago, Ill).

RESULTS

Energy Costs

Energy costs (€/MJ) for each food are shown in Figure 1. Energy costs for oil, margarine, potatoes, sugar, or beans were substantially less than energy costs for lean meat, vegetables, lettuce, or fish. As indicated by the logarithmic scale, disparities in energy cost between fats and fresh produce were in excess of 1000%.

Estimated Diet Costs

Mean energy intakes, without alcohol, were 9.89 MJ (2366 kilocalories [kcal]) for men and 7.38 MJ (1765 kcal) for women. Mean estimated diet cost was €5.59 per day for men and €4.62 per day for women. Women consumed more fruit and vegetables, fiber, and vitamin C per 10 MJ of dietary energy than did men. Mean energy cost per 10 MJ was higher for women (€6.56/10 MJ) than for men (€5.85/10 MJ).

Table 1 shows that higher consumption of grains and of fats and sweets was associated with lower diet costs after adjustment for energy intake, gender, and age. Higher intakes of sucrose and total fat were likewise associated with lower diet costs. In contrast, the consumption of fruit and vegetables was associated with higher diet costs, as was the consumption of meat. Higher consumption of dairy products was not associated with higher or lower diet costs.

The relationship between diet quality and diet costs is summarized in Table 2. Participants were divided into quintiles according to their consumption of fats and sweets (g/day), fruits and vegetables (g/day), fat and sucrose (as % energy). The dependent variables, shown as a function of consumption of different-type foods and nutrients, were total energy intakes (MJ/day), dietary energy density (MJ/kg), daily diet costs (€/day), and energy costs (€/10MJ).

Persons in the highest quintile of fats and sweets consumption (g/day) consumed more energy and had higher diet costs (€5.90/day) than did persons in the lowest quintile (€4.37/day). However, this higher diet cost was more than offset by a doubling of energy intake. As a result, energy costs were only €5.22 per 10 MJ for persons in the highest quintile, as opposed to €7.59 per 10 MJ for...
persons in the lowest quintile of fats and sweets consumption.

Energy costs per 10 MJ were €5.46 for persons in the highest quintile of sucrose intakes and €7.21 for persons in the lowest quintile. Persons in the highest quintile of fat intakes had higher energy intakes and higher dietary energy density, a pattern that is consistent with previous reports.[^32][^33] Higher fat consumption was associated with lower energy costs per 10 MJ, leading to lower absolute diet costs (€/day). Depending on the level of energy intake, each 100 g of fats and sweets was associated with a net reduction of €0.05 to €0.40 in daily diet costs. In contrast, each additional 100 g of vegetables and fruit was associated with a net increase of €0.18 to €0.29 per day in diet costs.

The finding that elevated consumption of fats and sweets is associated with lower diet costs is also likely to hold for US diets. The average retail price of sucrose in the United States is much lower than that in France, and total sugar consumption (including corn sweeteners) is twice as high.[^34] However, few studies on diet quality and estimated diet costs comparable to ours have been conducted in the United States. This lack of data is a major research gap, given that structural and policy interventions are needed to prevent obesity increasingly point to the need for fiscal and policy interventions.[^1][^9] At this time, there are no nationally representative US data on diet costs on which to base fiscal and food policies.

The model we used to estimate diet costs had some important limitations. Diet costs were estimated with mean national food prices, as opposed to actual food expenditures, and studies foods were limited to 57 foods. The model critically depends on the ability of the selected foods to represent each food category; an unrepresentative set of foods would greatly degrade the accuracy of the imputed diet costs. However, our overall estimate of approximately €5 per day was remarkably close to the national mean expenditure for food consumed at home (€4.9/day), as calculated by the French National Institute of Statistics. Our study was based on adults older than 18 years, and children and adolescents were not included. Another limitation

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**TABLE 2—Energy Intakes, Dietary Energy Density, and Diet and Energy Costs, by Quintiles of Intake of Selected Food Groups (g/Day) and Nutrients (% Energy)**

<table>
<thead>
<tr>
<th>Food Category</th>
<th>Quintiles of Intake</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fats and sweets (g/day)</td>
<td>25.6 ±9.7</td>
<td>47.2 ±4.9</td>
<td>66.3 ±5.7</td>
<td>89.5 ±8.8</td>
<td>227.0 ±169.5</td>
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<tr>
<td>Energy intake (MJ)</td>
<td>6.0 ±0.1</td>
<td>7.3 ±0.1</td>
<td>8.1 ±0.1</td>
<td>9.4 ±0.2</td>
<td>11.6 ±0.3</td>
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</tr>
<tr>
<td>Energy density (MJ/kg)</td>
<td>4.6 ±0.08</td>
<td>5.6 ±0.1</td>
<td>5.7 ±0.1</td>
<td>6.0 ±0.1</td>
<td>6.4 ±0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diet cost (€/day)</td>
<td>4.37 ±0.09</td>
<td>4.61 ±0.09</td>
<td>5.05 ±0.08</td>
<td>5.26 ±0.08</td>
<td>5.90 ±0.12</td>
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<tr>
<td>Energy cost (€/10 MJ)</td>
<td>7.59 ±0.15</td>
<td>6.45 ±0.10</td>
<td>6.31 ±0.08</td>
<td>5.66 ±0.07</td>
<td>5.22 ±0.07</td>
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<tr>
<td>Fruit and vegetables (g/day)</td>
<td>343 ±6</td>
<td>494 ±2</td>
<td>584 ±2</td>
<td>703 ±3</td>
<td>977 ±19</td>
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<tr>
<td>Energy intake (MJ)</td>
<td>8.1 ±0.2</td>
<td>8.1 ±0.2</td>
<td>8.1 ±0.2</td>
<td>8.7 ±0.2</td>
<td>9.4 ±0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy density (MJ/kg)</td>
<td>6.5 ±0.11</td>
<td>6.0 ±0.09</td>
<td>5.6 ±0.1</td>
<td>5.3 ±0.08</td>
<td>5.0 ±0.1</td>
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</tr>
<tr>
<td>Diet cost (€/day)</td>
<td>4.30 ±0.10</td>
<td>4.66 ±0.08</td>
<td>4.91 ±0.09</td>
<td>5.36 ±0.10</td>
<td>5.95 ±0.10</td>
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</tr>
<tr>
<td>Energy cost (€/10 MJ)</td>
<td>5.55 ±0.09</td>
<td>6.01 ±0.10</td>
<td>6.48 ±0.12</td>
<td>6.49 ±0.11</td>
<td>6.72 ±0.14</td>
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<tr>
<td>Total fat (% energy)</td>
<td>29.2 ±0.2</td>
<td>35.1 ±0.1</td>
<td>39.6 ±0.1</td>
<td>42.0 ±0.1</td>
<td>48.8 ±0.4</td>
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<tr>
<td>Energy intake (MJ)</td>
<td>7.6 ±0.2</td>
<td>8.5 ±0.2</td>
<td>8.7 ±0.2</td>
<td>8.9 ±0.2</td>
<td>9.3 ±0.3</td>
<td></td>
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</tr>
<tr>
<td>Energy density (MJ/kg)</td>
<td>4.9 ±0.1</td>
<td>5.5 ±0.1</td>
<td>5.7 ±0.1</td>
<td>6.0 ±0.1</td>
<td>6.3 ±0.1</td>
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</tr>
<tr>
<td>Diet cost (€/day)</td>
<td>4.76 ±0.11</td>
<td>5.04 ±0.10</td>
<td>5.08 ±0.10</td>
<td>5.28 ±0.09</td>
<td>5.01 ±0.11</td>
<td></td>
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</tr>
<tr>
<td>Energy cost (€/10 MJ)</td>
<td>5.69 ±0.15</td>
<td>6.21 ±0.11</td>
<td>6.14 ±0.10</td>
<td>6.13 ±0.09</td>
<td>6.09 ±0.10</td>
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<tr>
<td>Sucrose (% energy)</td>
<td>1.5 ±1.0</td>
<td>4.4 ±0.6</td>
<td>6.4 ±0.6</td>
<td>8.9 ±0.8</td>
<td>14.3 ±3.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy intake (MJ)</td>
<td>7.2 ±2.4</td>
<td>8.2 ±2.9</td>
<td>8.4 ±2.3</td>
<td>8.7 ±3.1</td>
<td>9.7 ±3.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy density (MJ/kg)</td>
<td>5.2 ±1.3</td>
<td>5.6 ±1.2</td>
<td>5.8 ±1.1</td>
<td>5.7 ±1.3</td>
<td>6.0 ±1.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diet cost (€/day)</td>
<td>4.92 ±1.18</td>
<td>5.09 ±1.46</td>
<td>5.09 ±1.23</td>
<td>4.94 ±1.29</td>
<td>5.13 ±1.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy cost (€/10 MJ)</td>
<td>7.21 ±1.83</td>
<td>6.46 ±1.51</td>
<td>6.18 ±1.08</td>
<td>5.93 ±1.22</td>
<td>5.46 ±1.14</td>
<td></td>
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</tbody>
</table>

Note. NS = not significant.

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**Table 2 continued...**

**Do "Prudent" Diets Cost More?**

To determine whether the relationship between diet structure and diet costs held for all levels of energy intake, participants were stratified by energy intake quintiles (MJ/day). Figure 2 shows the relationship between the fats and sweets consumption (g/day) and diet costs, with regression lines at each quintile of energy intake indicated by solid lines. For persons in the lowest energy quintile, each additional 100 g of fats and sweets was associated with a reduction in absolute diet cost of €0.40 per day. The relationship flattened as energy intakes increased so that, for persons in the highest energy quintile, each 100 g of fats and sweets was associated with an increase in diet costs of €0.05 per day.

In contrast, higher fruit and vegetable consumption was associated with higher diet costs. Figure 3 shows that each 100 g/day increment in fruit and vegetable consumption was associated with an increase in diet costs of €0.18 to €0.29 per day, depending on energy intake.

**DISCUSSION**

This cost analysis of freely chosen total diets in a French community sample showed that fats and sweets offer dietary energy at very low cost. At most levels of energy intake, higher consumption of fats and sweets was associated not only with reduced energy costs (€/10 MJ) but also with lower absolute diet costs (€/day). Depending on the level of energy intake, each 100 g of fats and sweets was associated with a net reduction of €0.05 to €0.40 in daily diet costs. In contrast, each additional 100 g of vegetables and fruit was associated with a net increase of €0.18 to €0.29 per day in diet costs.

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was the lack of detailed socioeconomic data on occupation and income.

Nonetheless, the study may provide insight into the effect of price structure on food choices. Sugar and fat consumption by the American public has become a major focus of obesity research. Metabolic studies have explored the neurobiology of food preference and the nature of cravings for fats and sweets. Environmental studies have examined the contributions of snacks, fast foods, caloric beverages, eating away from home, and growing portion sizes to the obesity epidemic. Links were established between excessive weight gain and the energy density of the diet. Very few studies have considered the economics of food choice and the very low energy cost of sugar and fat. Low-income consumers may select fats and sweets simply because they are palatable and because they provide dietary energy at the lowest possible cost. Given the current hierarchy of food prices, seeking to minimize diet costs may drive consumer food choices toward refined grains, potatoes, sugar, and fat.

The US Department of Agriculture dietary guidelines and the Food Guide Pyramid continue to stress the importance of vegetables and fruit. Public health approaches to obesity prevention have called for the imposition of small taxes and levies on sweet and high-fat foods. However, very few cost analyses of diet structure exist on which to base dietary guidelines, public health interventions, or fiscal food policy. It is debatable whether altering the absolute price of some foods without modifying the price hierarchy will have a desired effect on food choices. The relationships among fat and sugar consumption, food costs, and obesity have never been explored. Epidemiological studies have shown that “prudent” diets based on vegetables, fruit, whole grains, poultry, and fish are more protective than so-called Western diets, characterized by high consumption of added sugars and fat. In other words, more costly diets are associated with more favorable health outcomes. Persons making more costly food choices may well have additional financial resources and social capital, both of which may influence health status. Higher fruit and vegetable consumption and better health outcomes are generally associated with higher education and higher income levels. Food costs represent a barrier to dietary change, especially for low-income families, and our data indicate that the recommended “ prudent” dietary patterns are likely to cost more. Public health strategies and approaches to dietary change for health promotion would do well to take diet costs into account.
About the Authors

Adam Drewnowski is with the Center for Public Health Nutrition and the Nutritional Sciences Program, University of Washington in Seattle. Nicole Darmon is with the Institut National pour la Science et la Recherche Medicale Unit 557 and the Institut Scientifique et Technique de la Nutrition et de l’Alimentation at the Conservatoire National des Arts et Metiers in Paris, France. Andrei Brindis is with the Institut de Recherche pour le Developpement in Paris, France. Requests for reprints should be sent to Adam Drewnowski, PhD, Nutritional Sciences Program, 305 Bailey Hall, 353:410, University of Washington, Seattle, WA 98195-3410 (e-mail: adamdrew@u.washington.edu).

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Contributors

A. Drewnowski contributed to the planning of the study, performed data analyses, and wrote the article. N. Darmon planned and conceptualized the study, performed data analyses, and contributed to the writing of the article. A. Brindis contributed to the conception and design of the study, to the analysis and interpretation of data, and to critical revisions of the article.

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Human Participant Protection

The Val-de-Marne study was approved by the ethics committee of the Conservatoire National des Arts et Metiers—Paris. Analyses of data sets stripped of all identifying information were declared exempt from review by the University of Washington institutional review board.

References
