

Symposium: Modifying the Food Environment: Energy Density, Food Costs, and Portion Size

Food Choices and Diet Costs: an Economic Analysis^{1,2}

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ABSTRACT Obesity in the United States is a socioeconomic issue. It is related to limited social and economic resources and may be linked to disparities in access to healthy foods. Added sugars and added fats are far more affordable than are the recommended "healthful" diets based on lean meats, whole grains, and fresh vegetables and fruit. There is an inverse relationship between energy density of foods (kJ/g) and energy cost (\$/MJ), such that energy-dense grains, fats, and sweets represent the lowest-cost dietary options to the consumer. Good taste, high convenience, and the low cost of energy-dense foods, in conjunction with large portions and low satiating power, may be the principal reasons for overeating and weight gain. Financial disparities in access to healthier diets may help explain why the highest rates of obesity and diabetes are found among minorities and the working poor. If so, then encouraging low-income households to consume more costly foods is not an effective strategy for public health. What is needed is a comprehensive policy approach that takes behavioral nutrition and the economics of food choice into account. J. Nutr. 135: 900–904, 2005.

KEY WORDS: • energy density • energy cost • sugar • fat • economics

The obesity epidemic is not so much a failure of biological systems but a social and economic phenomenon (1). At the individual level, the prevalence of obesity is higher among groups with low education and low incomes (2,3). At the environmental level, highest rates of obesity are found in lower-income states, lower-income congressional districts, and in the most deprived areas (4,5). Based on aggregate census tract data, the proportion of families living in poverty was strongly associated with higher neighborhood rates of obesity and type 2 diabetes (6). Understanding how the high-risk vulnerable groups make food choices is a necessary component of nutrition intervention research. An analysis of the relationships among diet quality, food prices, and diet costs is the main topic of this article.

Rising obesity rates have long been linked to the food environment (7–9). Studies have explored the relative contribution of dietary sugars (10) and fats (11), eating away from home (9), growing portion sizes (12,13), and the energy density of the diet (14). "Supersized" portions of fast foods, snacks, beverages, and desserts have been singled out for special blame (15–17). Analyses of food supply trends over the past 30 y (18) show that portion sizes of energy-dense foods have increased the most. The combined effects of high energy density and large portion size may also lead to excess energy intakes and body weight gain (12,18).

The present hypothesis is that the observed links between food supply trends and rising obesity rates are mediated by the economics of food choice. The current structure of food prices is such that sweet and high-fat foods provide dietary energy at the lowest cost (1). The National Institutes of Health strategic plan for obesity research (19) observed that one reason for rising obesity rates may lie in abundant choices of relatively inexpensive calorically-dense foods that are convenient and taste good. Taste and convenience affect food choices, as do economic constraints (20). Consumers with limited resources may select energy-dense diets high in refined grains, added sugars and fats as an effective way to save money (21). An editorial in *The Lancet* (22) recently acknowledged that as long as a meal of grilled chicken, broccoli, and fresh fruit costs more and is less convenient than are the less healthy options, the battle for obesity will be lost.

Public health efforts to modify the food environment have followed one of two paths. One strategy has been to try and remove the offending low-cost foods from the consumers'

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reach. Hence, the proposals to restrict the sale of fats and sweets (19), limit the advertising and marketing of soft drinks (22,23), or impose taxes to discourage snack consumption (22,24). The strategy of using legal action as a weapon has led to sectors of the food and restaurant business facing lawsuits for their alleged role in promoting obesity among their clients (25–27). Whether a prohibition on selling low-cost foods to the low-income consumer is an effective way to stem the obesity epidemic is difficult to say. It is an issue for further behavioral and economic research.

An alternative strategy has been to improve access to healthier foods, including vegetables and fruit. Food access can be defined as financial, physical, or both. Fresh vegetables and fruit are not only more expensive (on a per calorie basis) than are fats and sweets, they are also less likely to be available in low-income neighborhoods. Among the efforts to redress such disparities are the USDA fruit and vegetable pilot program for schools and the USDA Senior Farmers' Market program, both of which aim to provide a variety of fresh fruits and vegetables to limited-resource groups. Proposals to reform agricultural subsidies, redraw import tariffs, and reshape food assistance programs all aim to improve access to more nutrient-dense foods by the low-income consumer (28).

The fundamental—and still controversial—question is whether healthier diets cost more (29). The scientific literature is divided on this point. Whereas a number of community studies have documented that healthier diets are associated with higher diet costs (30–33), many researchers continue to believe that such cost barriers are perceived rather than real (34,35). Hence, much effort is directed at “educating” the consumer, as opposed to modifying the food environment to remove disparities in access to healthier foods.

The low cost of energy-dense foods: time trends

Studies on the relative economy of foods in supplying dietary energy go back to the beginning of nutrition research in the United States. W. O. Atwater, generally regarded as the founder of USDA nutrition research, addressed the cost of protein—the nutrient of greatest interest at the time—as supplied by different foods (36). **Figure 1** shows a negative relationship between energy density (MJ/kg) and energy cost (cents/10 MJ), as based on 1887 food prices (37). The size of the bubble represents the amount of protein (g) that could be obtained for \$1.00 at that time. Wheat flour, dried beans, white bread, and cheese were both more energy-dense and less

expensive than were either seafood (oysters) or fresh fruit (oranges).

The issue of what foods can provide a nutritious diet at an affordable cost was also taken up in 1945 by George Stigler (38). The problem was solved using a computer optimization technique known as linear programming. Although the initial optimized diet met all nutritional requirements, it consisted of only 5 items: wheat flour, dried navy beans, evaporated milk, cabbage, and spinach (38). Later attempts to create optimal diets succeeded in increasing the number of foods and improving palatability and variety.

More recently, the USDA used a nonlinear optimization technique to create a diet that met the Recommended Dietary Allowances (RDAs) and the Pyramid Guidelines, while minimizing cost (39). Diet costs were estimated by attaching food prices to food records in the 1989 Continuing Survey of Food Intakes of Individuals (CSFII). The resulting Thrifty Food Plan (TFP) was described by the Economic Research Service of the USDA as a healthy diet, even though it was limited in variety and departed from the usual eating patterns (40). In 2002 the TFP cost an estimated \$107/wk for a family of 4, or approximately \$3.80 per person per day (40).

Figure 2, a bubble graph, shows energy density (MJ/kg) and energy cost (cents/10 MJ) for most of the foods listed in the TFP weekly menus. The size of the bubble is directly proportional to the amount of energy per week that was supplied by each food. Because the TFP market basket was composed of low-cost foods, energy was largely supplied by oil, shortening and mayonnaise, sugar, white bread, potatoes, and beans. Even in these nutritionally adequate baskets, the selection of fresh produce was severely limited. Oranges, apples, bananas, and grapes were the only fresh fruit. The amount of energy from lettuce or fresh tomatoes was minuscule. Of necessity much of the energy was supplied by refined grains, added sugars, and added fats.

No criticism of the TFP is intended. Linear programming studies obtained using French data sets and prevailing food prices in France (41) show that optimizing diets while minimizing costs inevitably led to diets that contained more cereals, more added sugars and fat and less lean meat, fish, cheese, vegetables, and fruit. Such diets are similar in composition to those already consumed by the poor (41). Yet there is a persistent belief that low-income consumers have made wrong or inappropriate food choices and need to be educated, taught, or motivated to behave otherwise. In reality, their food choices are quite rational from an economic standpoint and are confirmed by computer modeling of diets, once food costs are taken into account.

The hierarchy of food prices is similar in France and the U.S. and has not changed much in the past 120 y. Then as now, fats and oils, sugar, wheat flour, potatoes, and beans provided dietary energy at the lowest cost. However, major advances in agriculture and food science, not to mention farm subsidies, have widened the price gap between the cost of production of added sweeteners and vegetable oils as compared to that for dairy products, meat, and fresh produce. According to some sources, the cost to produce 1 lb of refined sugar can be as low as 4 cents (20). The American diet now derives close to 40% of daily energy from added sugars and from added fats. Perhaps as a result, the U.S. has the lowest-cost food supply in the world (42).

The trend toward lower-cost diets

Americans are consuming more refined carbohydrates, more added sugars, and more added fats (42). Total daily

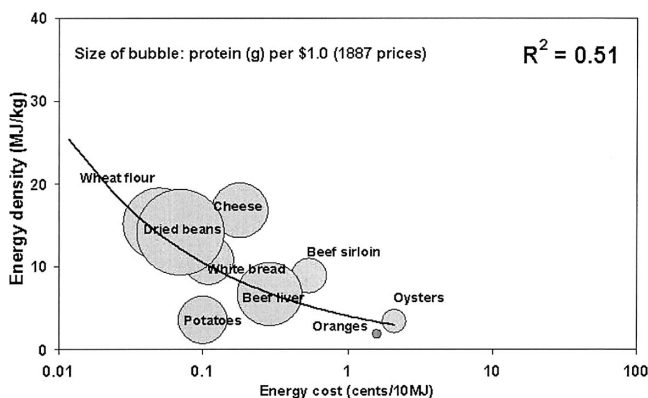


FIGURE 1 The relative economy of foods in supplying energy and protein. W. O. Atwater, 1887.

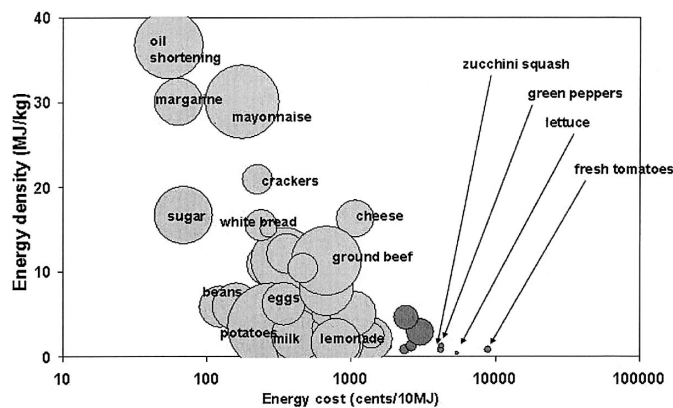


FIGURE 2 Energy density and energy costs for foods in the Thrifty Food Plan weekly menus. The size of the bubble represents energy from each food group for a family of 4 per week [from ref. (29)].

energy intakes increased by 300 kcal between 1985 and 2000. Refined grains accounted for 46% of the increase, added fats for 24%, and added sugars for another 23% (42). Growing consumption of foods away from home may have contributed to this trend. Generally, foods prepared away from home are higher in fat, sugar, and salt than are home-prepared foods (42). The percentage of spending on foods away from home rose from 25% in 1970 to 40% in 1995 (9). During that time, the proportion of meals and snacks eaten at fast-food restaurants increased by 200% (9). Added sugars and added fats, now accounting for close to 40% of daily energy intakes, help to keep down the cost of the American diet.

In contrast, the consumption of more expensive fruit increased by only 0.3 servings since the 1970s. In 2000 the food supply provided a daily average of 1.4 servings of fruit and fruit juices per person per day, and 3.8 servings of fresh and processed vegetables (42). Not surprisingly, the lowest-cost items continue to be consumed the most. Half of total fruit servings in 2000 were accounted for by only 6 items: orange juice (17%), bananas (9%), apple juice (8%), fresh apples (7%), fresh grapes (5%), and watermelon (4%). Low-cost potatoes (fresh, frozen, and potato chips), canned tomatoes, and iceberg lettuce accounted for 48% of total vegetable servings. The consumption of more nutrient-rich (but also more costly) leafy green vegetables was only 0.17 servings per day, whereas deep yellow vegetables added another 0.2 servings.

The proportion of disposable income spent on food continues to drop (42). In 1997 Americans spent 9.4% of income on food consumed at home and 4.1% on foods consumed away from home. Mean total expenditure on foods and beverages (including alcohol) was estimated at under \$8.00 per person per day. However, some consumers were more price conscious than others. USDA data indicate that low-income families were more likely to consume lower-cost, energy-dense diets (30). Such diets tend to provide cheap energy from fat, sugar, cereals, protein, and low-cost meat products, but contain relatively little whole grains, vegetables, and fruit.

Energy density and diet cost

There are few observational studies relating dietary energy density to energy costs. In a study of UK women, Cade et al. (31) found that diet quality, as measured by an index of fruit and vegetable intakes, was associated with higher diet costs. A study of French adults showed that higher fruit and vegetables intakes were associated with higher diet costs, after adjusting

for energy in regression models (43). A Danish study showed that low-fat diets for children tended to cost more (44). However, there is no consensus on this issue. Two intervention studies in the U.S. claimed that the newly-adopted diets were not more expensive than the initial lower-quality diets and some actually cost less (35,45). Likewise, an intervention study in children showed that low-fat diets did not lead to increased food costs (46).

The relationship between diet quality and diet cost needs to be examined in greater detail. Our hypothesis was that, for a set of freely-chosen diets, energy-dense diets would be associated with lower diet costs, after adjusting for energy. We therefore examined, for the first time, the relationship between dietary energy density and estimated diet costs in a sample of 837 French adults. Cost analyses were based on a French dietary data set (47), merged with national food prices provided by the French government. The edible portion of each food was taken into account in calculating diet weight. Dietary energy density (MJ/kg) was obtained by dividing energy intakes by the estimated edible weight of all foods and caloric beverages consumed (excluding alcohol). For each of the 57 food items in the database, we priced a single frequently-consumed example. Frozen and canned products were included and the choices tended toward store brands and the lower-priced options. Mean national retail prices for year 2000 for each of the 57 items were provided by the French National Institute of Statistics (INSEE). A column of prices in Euros (1€ = 1.17 US\$ in June 2003) was then added to the Val-de-Marne food composition database.

The relationships between energy density and diet cost were tested using multivariate regression analysis, adjusting for age and gender. Participants were also split by quintiles of energy intake (MJ/d) and the relationship between dietary energy density and diet costs was assessed separately for each quintile. **Figure 3** shows that, at each quintile of energy intake, energy-dense diets cost less (€/d) than did energy-dilute diets. The regression coefficients were significant in each case, although the slope was flatter for the top quintile of energy intakes. Adjusting for age and gender strengthened the association within each energy intake quintile.

Obesity: an economic framework

In economic terms, all individuals are bounded by 2 constraints when it comes to food consumption. The first one is

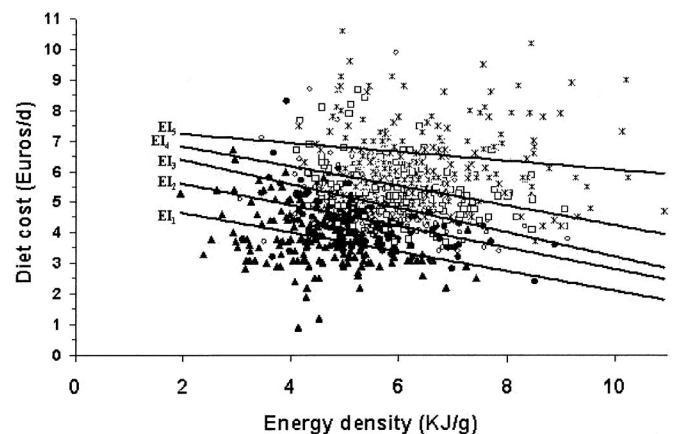


FIGURE 3 Inverse relationship between dietary energy density (KJ/g) and daily diet costs (Euros/d), for each quintile of energy intake (EI).

the need to secure a daily energy requirement of 2,000–2,500 kcal. The second is a budget or price constraint. Given those 2 constraints, each person's food choices are designed to maximize the so-called "utility," that is direct benefits associated with food consumption.

Consumption continues for as long as the marginal benefit of the next unit consumed is equal to or greater than its marginal cost. The marginal benefit, defined as an increase in utility, can take the form of reduced hunger, satisfaction, or sheer enjoyment. Although positive, it diminishes as more food is consumed. The 2 components of marginal cost are food price and the negative impact of any additional consumption on the utility function.

The observation that energy-dense foods and energy-dense diets are highly palatable (48) suggests that the marginal benefits of food consumption are high. The observation that the same foods provide dietary energy at a very low cost suggests that the marginal cost of consuming additional units is low. In the general population, consumers select foods on the basis of taste, cost, convenience, health, and variety (49). However, among low-income households and the unemployed, it is taste and cost that are the key determinants of food choice (49). Low-income families attempting to maintain food costs as a fixed percentage of diminishing income will be driven in the direction of energy-dense foods and a higher proportion of foods containing grains, added sugars, and added fats (50,51).

Obesity and the law

The basis of obesity lawsuits is that consumers are deceived or enticed by the food industry into overeating, if not actually made addicted to snacks and fast foods. The multiple legal theories can be characterized as addiction, enticement, deception, and social injustice. Plaintiffs who have adopted the addiction approach have strived to characterize energy-dense fast foods as the "tobacco of the 21st century" (25–27). Enticement is cited because "supersized" portions and selective advertising and marketing, especially to children, supposedly entice the consumer to overeat. Deception is cited because the industry has at times failed to reveal the exact nutrient content of food products, disclose that the foods contained trans fatty acids, or provide warning labels that excess consumption of sugar, fat, cholesterol, and salt can have detrimental effects on future health (52). The social injustice claim is based on alleged predatory marketing practices, placement of fast food outlets in low-income neighborhoods, and lack of access to fresh vegetables and fruit in the inner city. Many of these factors place minorities and the poor at a disadvantage when it comes to the adoption of healthier eating habits (52).

The basis of obesity defense is that the consumers are free to choose and are capable of saying no. The food industry has taken the position that providing a wide range of affordable foods and services is a clear benefit to the public. The key argument is that everyone has personal responsibility for his or her eating habits and is free to choose from among the available foods. The notion of freedom to choose is codified in expert panel and agency reports that exhort the public to "choose" healthy as opposed to unhealthy foods (53).

According to some legal theories, this freedom to choose is abrogated by the addictive nature of fast foods (52). However, there may be no need to invoke food addictions. Economic constraints limit food choices effectively enough. Because of food prices and diet costs, not all consumers have the same degree of choice when it comes to purchasing more healthful

diets. One question is whether the obesity problem is the responsibility of the food industry, which provides low-income consumers with overly cheap food. Or is there a broader problem that has to do with the declining value of the minimum wage, and growing inequalities in incomes and wealth?

CONCLUSION

A focus on the economics of food choice is greatly overdue. The obesity literature has addressed many aspects of overconsumption of sugars and fats (40,54), without mentioning their very low cost. Among the suggested strategies for reducing the consumption of low-cost foods are taxes, levies, and outright bans (19,22,24). Whether such regressive tactics will steer low-income groups toward healthier and more costly diets is an unresolved issue. We need more studies on diet quality and food costs on which to base responsible nutrition interventions and fiscal food policy.

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