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The Relative Costs of High- vs. Low-Energy-Density Foods and More vs. Less Healthful Beverages Consumed by Children

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Abstract

Objective: To compare grocery costs between relatively high energy density foods and sugar-sweetened/high-fat beverages and lower energy density foods and more healthful beverages in children's diets.

Methods: Sixty foods were divided into high and low energy density baskets. Fourteen beverages were designated to either basket based on fat and added-sugar content. Prices were collected at 60 grocery stores and composite costs compared between baskets using Wilcoxon tests.

Results: The cost per kilogram of high energy density foods was greater, but the cost per quart of sugar-sweetened/high-fat beverages was lower than more healthful beverages. The cost per 1000 calories and the cost per serving of the high energy density basket were lower.

Conclusions: The relative cost of high and low energy density foods in children's diets depends on how cost is quantified. "Pound-for-pound," lower energy density foods and more healthful beverages are generally less expensive, but high energy density foods and less healthful beverages

are cheaper per serving. Cost metrics including other factors (e.g. time cost) may further clarify the role of grocery prices in children's diets.

Keywords

food prices; energy density; beverages; grocery stores; children

Introduction

National surveys indicate that children in the United States obtain the largest proportions of their daily calories from high energy density, high-fat, sugary foods and beverages including grain-based desserts, sugar-sweetened beverages, pizzas, and high-fat milk.[1,2] In recent years, researchers have focused on identifying the social and environmental factors that may contribute to these consumption patterns.[3] A popular consumer perception is that healthful, nutrient-rich foods are more expensive than unhealthful, high-fat, and sugary foods and beverages.[4,5] Further, the relatively low cost and ubiquitous availability of such items, coupled with their palatability, have been implicated as contributors to their overconsumption.[6]

There is currently a debate among researchers about the accuracy of the perception that it is more expensive to consume a healthful diet. This debate is due, in part, to disagreement surrounding the relevance of different ways of defining cost (e.g. unit cost vs. cost per calorie).[7–18] Calls for taxes on such items as sugar-sweetened beverages, snacks, and fast food, as well as proposed subsidies for more healthful items, have sparked controversy and debate. However, research into the potential and actual effects of price manipulations on diet and obesity have provided disparate results.[19–24] Some studies do suggest that changes in the relative costs of more and less healthful items can influence purchasing behaviors.[25-32]

With regards to the cost of foods relative to their energy composition, some researchers have proposed a density-cost framework which posits that the association between poverty and obesity is due, at least in part, to a negative relationship between the energy density (calories per gram) of foods and their energy cost (cost per calorie).[33] Based on the observation of higher diet costs among French adults with lower dietary energy densities,[34] and subsequent work showing an inverse association between the overall energy density and energy cost of individuals' diets,[15,35] researchers have suggested that the higher prevalence of obesity among low-income populations is the result of attempts to obtain an adequate amount of calories on a limited budget by purchasing highly energy-dense foods. These foods, however, are generally high in fat and added sugars and tend to promote overconsumption and weight gain.[6] The relevance of this inverse energy density-energy cost association, however, has drawn some criticism from nutrition, obesity, and economics researchers.[8,10,12,14,16,18,36] Work by the United States Department of Agriculture's (USDA) Economic Research Service has also shown that whether less energy-dense foods and more healthful beverages are more expensive depends on how cost is defined.[37]

Although there is some evidence of differences in cost between foods of relatively higher and lower energy density,[7,12,37–39] no study to date has specifically examined the cost of foods consumed by children. The purpose of this study was to determine whether the high

energy density foods and high-fat and sugar-sweetened beverages consumed by children are less expensive than the low energy density foods and more healthful beverages in children's diets. This study also examined whether the relative costs of those items vary based on how cost is quantified. It was hypothesized that the cost per kilogram (unit cost) of low energy density foods would be lower than that of high energy density foods, but that the energy cost of low energy density foods and the energy cost and cost per quart (unit cost) of more healthful beverages would be higher. It was also believed that more healthful items would be more expensive when cost was quantified per serving.

METHODS

Study design

This study was a cross-sectional analysis of grocery prices in the city of Rochester, NY and the surrounding area (Monroe County) in western New York State. The units of analysis in this study were two distinct grocery "baskets" (i.e. two separate lists of different foods and beverages) for which prices were collected at 60 grocery stores. The dichotomous independent variable was basket type (high vs. low energy density), and the outcome of interest was the composite cost of the items in each basket.

High and low energy density basket development

To obtain composite measures of the general costs of relatively high and low energy density foods and more and less healthful beverages for comparison, two grocery baskets were created. The items for these baskets were selected based on the dietary intake of a sample of 6–11 year-old children from the 2005–2010 *What We Eat In America* (WWEIA) surveys, the dietary survey portion of the National Health and Nutrition Examination Survey (NHANES).

First, from the combined 2005–2010 WWEIA datasets, only those children who were 6–11 years old and had complete data on sex, age, race/ethnicity, and body mass index (BMI), and two completed 24-hour dietary recalls, were retained. The WWEIA datasets consist of separate observations for each food and beverage consumed by each child. For example, if a child consumed 25 different items over the two days of dietary recall, then there are 25 separate observations for that child, including nutrient profiles for the consumed quantity of each item. This dataset was further reduced to include only those items indicated as having come from a store, since only the costs of grocery items were of interest here, as opposed to items purchased at restaurants, cafeterias, or elsewhere.

The dietary intake of a subsample of WWEIA children was used to compile the high and low energy density baskets for comparison in this study. This subsample was selected by matching the 6–11 year-old WWEIA respondents on sex, age (months), race/ethnicity, and weight status (underweight, normal weight, overweight, obese) to a convenience sample of 1049 local children from a study of the relationship between local food prices and children's BMI. This was done so that the price comparisons in that study were reflective of items consumed by children in the United States with similar characteristics to the children in the

local sample. This process resulted in a total of 1402 unique store-bought foods and beverages consumed by the matched WWEIA respondents.

The proportion of the matched WWEIA respondents who consumed each item at least once over the two 24-hour dietary recalls was then determined, and the list was further narrowed by retaining only those items that were consumed by at least 5% of the matched sample of children on at least one of the two dietary recall days. This process resulted in a total of 60 foods and 14 beverages on the remaining list of grocery items. The energy density (calories per gram) of each food was calculated based on the nutrient profiles provided in the WWEIA dataset. The median energy density was then used to divide the 60 foods into relatively high and low energy density baskets.

Because the water content of beverages makes them all much more energy-dilute than foods, beverages were excluded from the calculation of the median energy density. Without doing so, all beverages, even those known to lack any nutritional value and contribute to obesity, would have been included in the low energy density basket. Sugar-sweetened beverages such as sodas, fruit drinks, and sports drinks, and higher fat milks (2% and whole) were designated to the high energy density basket, while water, 100% fruit juices, and low-fat milk (1%) were included in the low energy density basket. All foods and beverages included in the two baskets are listed in Tables 1 and 2.

Grocery store identification

A detailed business list was purchased from InfoUSA (Infogroup, Inc., Omaha, NE) to identify all local supermarkets and grocery stores in the Monroe County area. Data were received for all area businesses using North American Industrial Classification System (NAICS) codes 445110 (supermarkets and other grocery [except convenience] stores) and 452910 (warehouse clubs and supercenters) as either their primary or secondary business classification.[40] As defined by the Food Marketing Institute (FMI),[41] a conventional supermarket generally contains meat, produce, dairy, and frozen food departments, as well as a variety of packaged non-perishable grocery items, and brings in annual sales of $2 million or more. For this study, however, no annual sales cut-off was used in order to include smaller non-chain or locally-owned grocery stores. Prior to the collection of price data, each store with a primary or secondary NAICS code of 445110 or 452910 was assessed for whether or not it contained the aforementioned grocery store departments; those that did were included in the data collection. Due to their fee-based membership and bulk purchase requirements for most items, warehouse clubs were not considered as grocery stores within the context of this study. A total of 60 grocery stores meeting the above criteria were identified and included in this study.

Price data collection

All food and beverage prices were collected between November 2012 and January 2013. Before collecting price data, standard package sizes were defined (e.g. 16 oz. jar of peanut butter) for each item based on the observed availability of a limited selection of package sizes in local discount grocery stores. To make the basket contents highly comparable across

all stores in the study, package sizes commonly available in discount grocery stores were used.

At each grocery store, the brand of each item with the lowest unit price (price per gram or fluid ounce) was identified for the standard package size or the size closest to it. The size of the package (grams or fluid ounces), the cost of the package, and the following nutrition information were recorded: serving size (grams or fluid ounces); number of servings per package; number of calories per serving. The calories per package, energy density (calories/gram), energy cost ($/1000 calories), unit cost ($/kilogram or $/quart), and serving cost ($/package serving) for each item were then calculated from the recorded package and price data.

Basket cost calculations

Within each store the package prices of all items were summed for each basket to determine the total high and low energy density basket prices for that store. The total weight of foods (grams), total quarts of beverages, and total calories across all items within each basket were also calculated. The unit cost, quart cost, energy cost, and serving cost variables were then calculated for each basket within each store as follows:

unit cost = (total food cost/total food grams)*1000

quart cost = (total beverage cost/total beverage ounces)*32

energy cost = (total basket cost/total basket calories)*1000

serving cost = median cost per serving across all foods and beverages

A serving was defined as the serving size listed on the Nutrition Facts panel of all non-produce packaged items. The serving sizes for fresh produce were defined as 1 medium apple, 1 banana, 1 orange, 1 white potato, 1 cup of lettuce, ½ cup of carrots, ½ cup of cucumbers, ½ cup of grapes, and ½ cup of tomatoes. Cost ratios for each grocery store were also calculated by dividing the high energy density basket costs by the low energy density basket costs in order to quantify the differences in cost between the two baskets within each store. These ratios were calculated for unit cost, quart cost, energy cost, and serving cost. As high:low energy density cost ratios increase, the cost of the foods and beverages in the low energy basket decreases, relative to the cost of the items in the high energy density basket.

Statistical analyses

For each high energy density basket there was a corresponding low energy density basket drawn from the same store, making the two baskets paired samples. Because all cost variables (unit cost, quart cost, energy cost, serving cost) were not normally distributed, nonparametric Wilcoxon signed-rank tests were used to test for differences in the cost variables between the high and low energy density baskets. A two-sided alpha of 0.05 was used to determine the significance of the differences in each of the four cost variables between the high and low energy density baskets. All analyses were conducted using SAS version 9.3 (SAS Institute, Cary, NC). All study activities were approved by the University of Rochester Research Subjects Review Board.

RESULTS

All of the high and low energy density basket items were located in 40 (66%) of the 60 grocery stores. Of the 20 stores with missing items, 18 were missing only one or two items from the same basket, one store was missing four items (1 high energy density, 3 low energy density), and one store was missing six items (3 high, 3 low). Because these missing items accounted for only 0.8% of the 4,440 total items (74 items x 60 stores), we did not consider these missing data to substantially affect the composite basket costs, so no imputations or adjustments were made.

The distributions of the cost variables for the high and low energy density baskets, as well as the high:low energy density cost ratios, are shown in Table 3. The unit cost of the low energy density foods was significantly lower than the unit cost of the high energy density foods ($p<0.0001$). The distribution of unit cost ratios indicates that, in most of the surveyed stores, the cost per kilogram of the high energy density foods was at least 50% (range: 26% - 89%) greater than the cost per kilogram of the low energy density foods. The unit cost (cost per quart) of the sugar-sweetened and high-fat beverages was at least 24% lower (range: 3% - 39%) than the 100% fruit juices and low-fat dairy beverages in the low energy density basket in most stores ($p<0.0001$).

The energy and serving costs for both foods and beverages in the low energy density basket were significantly greater than those of the items in the high energy density basket ($p<0.0001$). The median energy cost ratio for foods shows that when cost is calculated per 1000 calories, the cost of the high energy density foods was 51% lower (range: 30% - 62%) than the cost per 1000 calories of low energy density foods in the majority of stores, and the energy cost of the sugar-sweetened and high-fat beverages was 30% (range: 20% - 48%) lower than the energy cost of the juices and low-fat dairy in the low energy density basket. Additionally, the serving cost ratios indicate that the cost per serving of the high energy density foods was at least 10% lower (range: 0% - 33%) than the serving cost of the low energy density foods in most stores, and the sugar sweetened and high-fat beverages were, on average, 35% less expensive (range: 14% - 51%) per serving than the juices and low-fat dairy beverages in the low energy density basket.

DISCUSSION

Using different definitions of cost, this study compared grocery store prices between a basket of relatively high energy density foods and unhealthful beverages and a basket of lower energy density foods and more healthful beverages that are consumed by children in the U.S. The results support the hypotheses that high energy density foods are more expensive per kilogram, compared to low energy density foods, but high energy density foods and unhealthful beverages are cheaper when cost is calculated per calorie, per serving, or per quart.

These findings of variability in relative high and low energy density costs across different cost definitions are consistent with those of previous studies. Others have also shown low energy density items (fruits and vegetables) to have significantly greater energy costs than

high energy density items, but unit costs (per kg) that are less than or similar to the unit costs of higher energy density foods.[7,12,37] A USDA study[37] found the unit cost of fruits and vegetables to be significantly lower than that of items containing excessive amounts of sodium, saturated fat, and/or added sugars ("moderation foods"). Similarly, Drewnowski[7] and Lipsky[12] found fresh produce items to be cheaper in terms of unit cost, compared to more highly energy-dense food groups. Todd et al.,[38] however, observed differences across food categories in the relative unit prices of more and less healthful items. They found whole fruit to be as much as 70% cheaper than packaged sweet and savory snacks, and low-fat milk up to 35% cheaper than whole and 2% varieties, while also observing whole grains to be up to 65% more expensive than refined grains, dark-green vegetables costlier than starchy vegetables, and low-fat milk and 100% juices significantly more expensive per 100 grams than soda and fruit drinks, respectively. Energy cost, on the other hand, has been consistently found to be significantly greater among relatively low-calorie foods, such as fruits and vegetables, compared to more energy-dense sweets, grains, beans/nuts, dairy products,[3] snack foods,[8] and other unhealthful "moderation foods."[37]

The current finding of the average cost per serving of the low energy density basket being significantly greater than the cost per serving of the high energy density basket is also consistent with most prior studies that have included serving costs in their analyses.[7,12,42] Only Carlson and Frazao[37] found the lowest energy density food groups (fruits and vegetables) to be significantly *less* expensive per serving than items high in saturated fat, sugar, and/or sodium. This discrepancy between their findings and those of this study may be due to the use of different definitions of a serving between studies. In this study, a serving was defined as the serving size listed on the Nutrition Facts panel of all non-produce packaged items. For fresh produce items generally consumed one whole unit at a time (apples, bananas, oranges, white potatoes), a serving was defined as one medium unit, 1 cup was the serving size for lettuce, and ½ cup was used as the serving size for all other produce items (baby carrots, cucumbers, grapes, tomatoes). In contrast, Carlson and Frazao used the average portion size within each food group consumed by 2003–2004 NHANES adult respondents. Prior studies using serving sizes similar to those in this analysis also found the lowest energy density items to be significantly *more* expensive per serving than the highest energy density foods.[7,12,42]

These findings have potential implications for the absolute amounts and proportions of high and low energy density foods and more and less healthful beverages in children's diets. Controlled shopping trials have provided evidence that changes in the relative costs of more and less healthful foods can impact individual purchasing decisions. Epstein et al. observed that mothers of young children tended to purchase more total food and calories when low energy density prices were reduced, but they were more likely to substitute low for high energy density foods and decrease total calories purchased when high energy density prices were raised.[26,27] Similarly, Giesen et al.[43] and Nederkoorn et al.[44] reported significant decreases in total calories purchased and calories from high energy density items when those high energy density items were taxed. Decreasing prices of relatively healthful low energy density items and increasing unhealthful high energy density prices have also been associated with more healthful purchasing patterns from vending machines[29–31] and in real and simulated cafeteria trials.[32,45,46] However, it should be noted that previous studies and

the current analysis have not addressed the potential for bidirectional causality. It is possible that consumers who favor and plan to consume high energy density foods and other less healthful items may intentionally seek out and shop at the places where such items are known to be less expensive. Future studies should be designed to address this issue.

There are some limitations to the design and methods of this study that should be noted when interpreting the results. First, the generalizability of the high and low energy density grocery baskets, as far as being representative of the foods consumed by children across the U.S., may be limited by the method that was used select the basket items. As part of a broader study of local food prices and children's BMI, the local convenience sample that was matched to NHANES respondents on gender, age, race/ethnicity, and BMI percentile, consisted of mostly minority children (61.5% non-Hispanic black, 19.7% white, 14.2% Hispanic, 4.6% other) with a substantially greater prevalence of overweight and obesity (42.5%) compared to the most recent estimates for all 6–11 year-olds in the United States (32.6%).[47] However, over half of the items surveyed in this study are included in one of the top categories from which children and adolescents in the U.S. are known to obtain the greatest proportions of their daily calories.[2] Therefore, it may be reasonably assumed that the high and low energy density baskets in this study are a good representation of the most commonly-consumed items among U.S children.

Additionally, food and beverage prices for this study were only collected from area grocery stores. The costs of items at other locations (e.g. restaurants, convenience stores) that may contribute substantially to some children's diets were not considered. However, the specific aim of this study was to compare costs between high and low energy density items in grocery stores, and it is estimated that children in this age group obtain, on average, nearly two thirds of their calories from store-bought foods.[48]

It should also be noted that the foods compared in this study were dichotomized based solely on their energy density, as the specific purpose of this study was to examine whether there are differences in the general cost of foods of relatively higher and lower energy density. While the use of energy density as an indicator of an item's general healthfulness appears to have been more valid for classifying unhealthful foods and beverages, some items in the lower energy density basket are likely to be considered "unhealthful" by other standards. For example, items such as canned vegetables, lunch meats, and Ramen noodle soups are generally high in sodium, and 100% fruit juices can be similar in sugar content to sweetened drinks and do not contain all of the nutrients that are found in whole fruits. Additionally, ice cream is generally considered an unhealthful snack and is often high in fat and sugar, though its relatively low energy density compared to the other commonly-consumed foods placed it in the low energy density basket as well. Boxed macaroni and cheese, which contains refined flour and is generally prepared using full-fat milk and butter, is also relatively low in energy density once cooked and so was included in the low energy density basket. However, the use of energy density as a marker of the healthfulness of foods, and energy cost as an indicator of food prices, are consistent with some previous literature and therefore allows for comparisons across studies.

An important distinction between this study and previous work is that this study compared grocery costs among foods and beverages that are known to be consumed by children in the U.S. Previous studies, on the other hand, have either arbitrarily chosen items to represent particular food groups or examined all items consumed by all respondents of national food surveys. This distinction is important because the method used here likely provides a comparison of prices between more and less healthful items that actually comprise a significant proportion of children's daily calories. The current results, therefore, may better reflect the relative costs of high and low energy density foods and different types of beverages currently consumed by children. However, the possibility remains that items may be commonly consumed, in part, because of their cost. This potential for causation in either direction should be recognized when interpreting these findings.

An additional strength of this analysis is that the unit, energy, and serving cost variables calculated were composite measures of the costs of various high and low energy density items spanning different food groups (Table 1). In addition to fresh and canned fruits and vegetables, the low energy density basket contained meat and poultry, eggs, dairy, grains, condiments, and snacks, while the high energy density basket also contained items from most of the same food groups. This is in contrast to other studies that have generally reported and compared costs of individual food groups (e.g. fruits and/or vegetables vs. grains vs. meat, etc.) Given the diversity of the items within the baskets used here, these results may more strongly support a relationship between cost and energy density, per se, as opposed to food category. Though this study provides further evidence of a positive association between the energy density and unit cost of foods, it remains unclear whether the misunderstanding of this association is responsible for the popular perception that healthful foods are more expensive. The results of this study show a clear difference in the relative costs of high and low energy density foods and more and less healthful beverages depending on the cost definition used and highlight the necessity of gaining a better understanding of how consumers conceptualize food cost when making purchasing decisions. Such an understanding would better inform future studies of the relationship between food costs, diet, and weight, and could guide public health and policy interventions to improve the affordability and consumption of healthful diets. Though monetary cost is an important characteristic, other metrics may be necessary to more fully capture the concept of dietary "cost," as it may include considerations such as convenience, availability, transportation, preparation (i.e. "time cost"), storage, and potential for waste. To properly address the economic concerns that are particularly constraining among low-income families, more qualitative work should be done to describe the components of the food environment and grocery shopping experience that contribute to the perception of relative food costs, with the aim of more accurately quantifying the costs and benefits of purchasing healthful and unhealthful items.

Though this study shows that diverse groups of high and low energy density foods consumed by children differ significantly in cost, this does not necessarily equate to the costs of children's overall diets being associated with their dietary energy density. Previous work has suggested a negative association between overall dietary energy density and total diet cost among adults.[29,30] However, like most studies of food prices, diet cost in those studies was estimated based on national average prices. Given the variability in prices across stores in

this study and the substantial regional differences in food costs observed previously,[32] studies using individual diet cost estimates based on food prices of areas more proximal to subjects may better reflect the association between diet cost and diet quality.

Conclusions

This study shows significant differences in cost between high and low energy density foods and more and less healthful beverages, regardless of how cost is defined (per unit, per 1000 calories, or per serving), and highlights the need for a better understanding of consumer perception of food costs in order to better inform practical dietary recommendations and interventions. Future research should attempt to combine retail prices with other factors (e.g. convenience, time cost of preparation) in order to better quantify the contribution of food and beverage costs to children's diets and weight status.

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Table 1.

High energy density basket items and their mean energy densities and median unit, energy, and serving costs

	Calories per gram	$/1000 g or quart	$/1000 calories	$/serving
Bologna	3.07	$3.28	$1.05	$0.11
Bread, wheat or cracked wheat	2.78	$3.86	$1.51	$0.18
Bread, white	2.65	$1.92	$0.73	$0.09
Butter	7.17	$5.04	$0.71	$0.07
Cheese, natural, block	4.02	$8.80	$2.24	$0.25
Cheese, processed, slices	3.29	$6.59	$2.09	$0.13
Cheese puffs/curls	5.63	$9.02	$1.80	$0.25
Chicken wings	2.97	$9.10	$6.11	$1.18
Chocolate chip cookies	4.81	$5.96	$1.32	$0.18
Chocolate sandwich cookies	4.68	$4.90	$1.01	$0.18
Crackers (e.g. Ritz® or Clubhouse®)	5.03	$6.59	$1.32	$0.10
Froot Loops® cereal (or generic)	3.80	$5.75	$1.42	$0.18
Frosted Flakes® cereal (or generic)	3.67	$4.13	$1.07	$0.13
Fruit-flavored drink, powdered mix	NA	$0.34	$1.30	$0.08
Fruit juice drink, ≤25% juice	NA	$0.62	$2.22	$0.16
Fruit juice drink, reduced sugar	NA	$1.20	$7.47	$0.30
Fruit snacks	3.65	$10.98	$3.16	$0.25
Gatorade® sports drink (or generic)	NA	$0.98	$4.45	$0.31
Hard candy (e.g. Jolly Ranchers®)	3.95	$7.25	$1.87	$0.13
Hot dogs, beef	3.35	$8.80	$3.13	$0.50
Jelly	2.67	$1.97	$0.79	$0.04
Margarine-like spread	5.29	$3.73	$0.87	$0.05
Mayonnaise	7.16	$3.40	$0.48	$0.05
Microwave popcorn, buttered	5.74	$5.33	$1.10	$0.18
Milk, 2%	NA	$0.75	$1.44	$0.19
Milk, whole	NA	$0.75	$1.25	$0.19
Pancake syrup	2.64	$2.20	$0.85	$0.18
Peanut butter	5.88	$4.88	$0.78	$0.16
Pop-Tarts® (or generic)	3.91	$5.26	$1.37	$0.27
Pork bacon	5.41	$9.90	$6.24	$0.55
Potato chips	5.45	$6.31	$1.14	$0.18
Roll, white	2.79	$3.64	$1.42	$0.16
Soft drink, cola	NA	$0.42	$0.99	$0.10
Soft drink, fruit-flavored	NA	$0.53	$1..05	$0.14
Sugar	3.85	$1.32	$0.35	$0.01
Tea, sweetened	NA	$0.87	$2.42	$0.22

	Calories per gram	$/1000 g or quart	$/1000 calories	$/serving
Tortilla chips	4.91	$5.93	$1.19	$0.17
Tortilla, wheat flour	3.08	$3.51	$1.38	$0.25
Waffles, frozen	3.10	$5.38	$2.11	$0.38

Table 2

Low energy density basket items and their mean energy densities and median unit, energy, and serving costs

	Calories per gram	$/1000 g or quart	$/1000 calories	$/serving
Apple juice	NA	$0.96	$2.01	$0.24
Apples	0.52	$3.50	$6.71	$0.48
Baby carrots	0.40	$2.18	$5.88	$0.14
Bananas	0.89	$1.69	$1.90	$0.20
Beef steak	2.09	$10.98	$6.43	$1.23
Bread, whole wheat	2.62	$3.51	$1.25	$0.14
Chicken breast	1.83	$5.15	$5.24	$0.58
Chicken drumsticks	2.06	$4.29	$3.01	$0.49
Corn, canned	0.88	$1.13	$1.77	$0.14
Cucumbers	0.12	$2.18	$16.52	$0.13
Eggs	1.73	$2.99	$2.14	$0.15
Fruit juice blend, 100% juice	NA	$1.39	$2.80	$0.35
Grapes	0.69	$6.86	$9.98	$0.55
Green beans, canned	0.31	$1.19	$7.15	$0.14
Ham, luncheon meat	1.29	$10.57	$9.65	$0.55
Ice cream, vanilla	2.05	$3.21	$2.02	$0.22
Ice pop	0.79	$2.39	$2.76	$0.17
Lettuce	0.13	$2.31	$15.85	$0.13
Macaroni and cheese, boxed	1.67	$2.75	$0.80	$0.19
Milk, 1%	NA	$0.72	$1.64	$0.18
Mustard	0.67	$2.45	NA	$0.01
Oranges	0.47	$3.01	$6.22	$0.39
Orange juice	NA	$1.00	$2.26	$0.25
Pancakes, frozen	2.25	$4.90	$1.82	$0.42
Ramen noodles	0.67	$3.51	$0.79	$0.15
Rice, white	1.29	$1.45	$0.43	$0.07
Salsa	0.24	$3.66	$11.71	$0.12
Spaghetti	1.57	$2.19	$0.59	$0.12
Spaghetti sauce, with meat	0.98	$1.86	$3.11	$0.23
Tomato catsup	0.97	$1.86	$2.11	$0.03
Tomatoes	0.18	$4.38	$24.66	$0.39
Tortilla, corn flour	2.18	$2.77	$1.31	$0.15
Turkey, luncheon meat	1.14	$10.57	$9.45	$0.55
Water	NA	$0.24	NA	$0.07
White potatoes	0.92	$1.10	$1.10	$0.19

Table 3.

Distributions of all cost variables and high:low energy density cost ratios across 60 grocery stores in Monroe County, NY

	Min.	25th percentile	Median	75th percentile	Max.
Energy cost (foods) *					
High energy density	0.76	1.17	**1.26**	1.56	1.69
Low energy density	1.80	2.37	**2.55**	2.98	3.37
High:low ratio	0.38	0.47	**0.49**	0.51	0.70
Energy cost (beverages) *					
High energy density	1.26	1.44	**1.68**	1.78	2.46
Low energy density	1.82	2.20	**2.51**	2.64	3.51
High:low ratio	0.52	0.65	**0.70**	0.76	0.80
Serving cost (foods) *					
High energy density	0.11	0.15	**0.17**	0.22	0.25
Low energy density	0.14	0.17	**0.19**	0.24	0.28
High:low ratio	0.67	0.81	**0.90**	0.98	1.01
Serving cost (beverages) *					
High energy density	0.12	0.14	**0.19**	0.19	0.24
Low energy density	0.17	0.21	**0.24**	0.29	0.32
High:low ratio	0.49	0.64	**0.65**	0.78	0.86
Unit cost (foods) *					
High energy density	4.08	5.35	**5.93**	7.35	8.25
Low energy density	2.84	3.65	**3.72**	4.70	5.45
High:low ratio	1.26	1.42	**1.53**	1.58	1.89
Unit cost (beverages) *					
High energy density	0.44	0.53	**0.63**	0.66	0.91
Low energy density	0.49	0.71	**0.81**	0.94	1.16
High:low ratio	0.61	0.71	**0.76**	0.80	0.97

Energy cost=$/1000 calories; serving cost=$/package serving; unit cost (foods)=$/kilogram

unit cost (beverages)=$/quart

* $p<0.0001$ for difference between high and low energy density baskets using Wilcoxon signed-rank tests