6. Dickert N, DeRiemer K, Duffy PE, et al. Ancillary care responsibilities in observational research: two cases, two issues. *Lancet.* 2007;369(9564):874–877.

7. Richardson HS. Gradations of researchers' obligation to provide ancillary care for HIV/AIDS in developing countries. *Am J Public Health.* 2007;97(11): 1956–1961.

8. Participants in 2006 Georgetown University Workshop on Ancillary-Care Obligations of Medical Researchers Working in Developing Countries. The ancillary-care obligations of medical researchers working in developing countries. *PLoS Med.* 2008;5(5):e90

9. Richardson HS. Incidental findings and ancillary-care obligations. *J Law Med Ethics.* 2008;36(2):256–270. 211.

10. Tielsch JM, Darmstadt GL, Mullany LC, et al. Impact of newborn skin cleansing with chlorhexidine on neonatal mortality in southern Nepal: a community-based cluster-randomized trial. *Pediatrics.* 2007;119(2):e330–e340.

11. Smith P. The duty to rescue and the slippery slope problem. *Soc Theory Pract.* 1990;16:19–41.

12. Scanlon TM. *What We Owe to Each Other.* Cambridge, MA: Harvard University Press; 1998:224.

13. Dreyfuss ML, Stoltzfus RJ, Shrestha JB, et al. Hookworms, malaria and vitamin A deficiency contribute to anemia and iron deficiency among pregnant women in the plains of Nepal. *J Nutr.* 2000; 130(10):2527–2536.

14. Schistosomiasis and Intestinal Parasites Unit, Division of Control of Tropical Diseases. Report of the WHO informal consultation on hookworm infection and anaemia in girls and women. December 5–7, 1994; Geneva, Switzerland. WHO/CTD/SIP/96-1.

15. West KP Jr, Katz J, Khatry SK, et al. Double blind, cluster randomised trial of low dose supplementation with vitamin A or beta carotene on mortality related to pregnancy in Nepal. The NNIPS-2 Study Group. *BMJ.* 1999;318(7183):570–575.

16. Emanuel EJ, Wendler D, Grady C. What makes clinical research ethical? *JAMA.* 2000;283(20):2701–2711.

The Impact of Food Prices on Consumption: A Systematic Review of Research on the Price Elasticity of Demand for Food

Tatiana Andreyeva, PhD, Michael W. Long, MPH, and Kelly D. Brownell, PhD

In light of proposals to improve diets by shifting food prices, it is important to understand how price changes affect demand for various foods.

We reviewed 160 studies on the price elasticity of demand for major food categories to assess mean elasticities by food category and variations in estimates by study design. Price elasticities for foods and nonalcoholic beverages ranged from 0.27 to 0.81 (absolute values), with food away from home, soft drinks, juice, and meats being most responsive to price changes (0.7–0.8). As an example, a 10% increase in soft drink prices should reduce consumption by 8% to 10%.

Studies estimating price effects on substitutions from unhealthy to healthy food and price responsiveness among at-risk populations are particularly needed. (*Am J Public Health.* 2010;100:216–222. doi: 10.2105/AJPH.2008.151415)

THE INCREASING BURDEN OF diet-related chronic diseases has prompted policymakers and researchers to explore broad-based approaches to improving diets.[1,2] One way to address the issue is to change the relative prices of selected foods through carefully designed tax or subsidy policies. The potential of price changes to improve food choices is evident from growing research on how relative food prices affect dietary quality and obesity, particularly among young people, lower income populations, and those most at risk for obesity.[3] Experience from tobacco tax regulation further underscores the power of price changes to influence purchasing behavior and, ultimately, public health.[4]

Experimental research in both laboratory and intervention settings shows that lowering the price of healthier foods and raising the price of less healthy alternatives shift purchases toward healthier food options.[5–8] Although these studies demonstrate price effects in specific, isolated settings or on 1 or 2 individual product changes, to our knowledge, the expected effects of broader food price changes have not been systematically reviewed. Such information would be helpful in designing policies that change the relative food and beverage prices paid by all or many consumers.

Relatively small-scale, cost-neutral approaches to improving nutrition in vulnerable populations include the 2009 changes in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) food packages; whole grains, fruits and vegetables, and soy-based milk alternatives were added to these packages, indirectly subsidizing healthy foods for WIC participants.[9] Another larger scale approach is to change prices directly through taxing products such as sugar-sweetened beverages[1,10] or subsidizing healthier foods (e.g., a refund on the costs of fruits and vegetables to Supplemental Nutrition Assistance Program participants).[11] Some states already tax soft drinks and snacks at higher rates than other foods, but thus far taxes have been small and designed to generate revenue rather than influence consumption.[12]

We sought to estimate the effects of price changes on consumer demand for major commodity foods included in the Dietary Guidelines for Americans food categories.[13] We identified all published US studies of food price elasticity of demand (the expected proportional change in product demand for a given percentage change in price) and combined their estimates into average estimated price elasticities for 16 major food and beverage groups. Our goal was to provide a comprehensive summary of research on food demand and consumption behavior in the United States over the past 7 decades, with particular attention to differences in price effects across income levels.

One timely estimate that can be gained from our review is how altering the prices of soft drinks can alter their consumption, information that is of critical need for policymakers considering soft drink taxes. We compared the sensitivity of estimates across different analytic approaches to modeling food demand. We identify important gaps in the food demand analysis literature and suggest avenues for future research.

METHODS

We reviewed all US-based studies on the price elasticity of demand for major food categories to determine mean price elasticities by category and assess variations in estimates by study design.

Definition of Terms

The price elasticity of demand is a dimensionless construct referring to the percentage change in purchased quantity or demand with a 1% change in price. It is determined by a multitude of factors: availability of substitutes, household income, consumer preferences, expected duration of price change, and the product's share of a household's income.[14] When the relative change in purchased quantity is below the relative change in price, demand is inelastic (numerically, the absolute value of price elasticity is below 1.0). In contrast, changes in demand that exceed the relative price change reflect elastic demand (the absolute value of price elasticity is above 1.0). For example, when a commodity's purchased quantity falls by 5% owing to a 10% increase in price, the price elasticity of demand is −0.5, reflecting inelastic demand. If the same price increase reduces the commodity's purchased quantity by 15%, demand for the product is elastic (–1.5).

Our review of food price elasticities focused on the effects of price changes on primary demand (also called commodity or category demand), which is consumer demand for a category or group of products measured by quantity purchased. By contrast, brand demand reflects purchases of an individual brand or products. In the case of policy decisions such as those involving taxation or subsidies, parameters of primary demand for a category of products (e.g., soft drinks) are necessary to predict the magnitude of policy-induced changes in consumer demand.

We distinguish between uncompensated and income-compensated price elasticity of demand, with the latter assuming that consumers are compensated for price changes through income changes (i.e., compensated models estimate only substitution between products without including any effects on a consumer's overall budget resulting from price changes). We consider both price demand elasticity and cross-price elasticity of demand for a product. Whereas price elasticity reflects changes in the purchased quantity of a commodity with changes in that commodity's price, cross-price elasticity reflects changes in demand for a particular commodity when prices of other products change. The construct of cross-price elasticities is important from a policy perspective in that relative shifts in prices through taxation or subsidies can affect demand for other products not regulated by policies.

Selection of Studies

Our review included US-based studies estimating the price elasticity of demand for food and nonalcoholic beverages. We reviewed original research articles published in English between 1938 and September 2007. Two independent searches were conducted with the search terms "food and price elasticity," "price elasticity," "demand elasticity," "food demand," and "price elasticities," as well as combinations of these terms with "food," "meat," "beverages," and "dairy." We used a number of databases and search engines to retrieve articles for review, including PubMed, EconLit, JSTOR, and Google Scholar. The reference lists of all retrieved articles were reviewed to identify relevant papers.

In addition to studies published in peer-reviewed journals, our search included working papers, dissertations, and US Department of Agriculture (USDA) technical reports. We retrieved these documents to capture all expert work, particularly USDA studies that appear only in government reports. Tests confirmed the sensitivity of our results to the exclusion of studies from non-peer-reviewed sources. Commentaries, editorials, essays, and consensus statements were excluded. We limited our review to US data because of the possibility of cross-country variations in market, product, and consumer characteristics introducing bias into our interpretations of food price effects in US studies. We included studies focusing on specific population groups or geographic regions to capture all variance in the US data.

Data Extraction and Analysis Variables

Data were independently extracted by one reviewer (T.A. or M.L.) and checked for consistency by the other reviewer. Variables assessed were food product, demand estimation model, data characteristics (study design, time, and source), estimates of price elasticity for all foods and nonalcoholic beverages, estimates of cross-price elasticity for major substitutes or complementary foods, demand elasticity for average and low-income households (if available), statistical significance of elasticity estimates, and publication source and year. Synthesizing data on income elasticity of food demand (food demand responsiveness to income changes)

was beyond the scope of our review. We did not use price elasticities for specific types of fruits or vegetables in estimating average fruit and vegetable elasticities because, as a result of the availability of substitutes, demand for specific foods such as apples is more elastic than that for an aggregate group that includes all fruits.

We used the following procedure to extract elasticity estimates. When estimates from multiple periods were reported, we selected the most recent data. In studies providing estimates of both compensated and uncompensated demand elasticity, we used uncompensated elasticity because most of the reviewed studies included only uncompensated demand estimates. We rounded final estimates to the second digit and calculated these estimates as absolute values. In studies with estimates from multiple models, we took mean values. We were interested in estimating the elasticity of fruit prices separately from that of vegetable prices. However, many studies included only one estimate for fruits and vegetables combined, and in these instances we had to assume the same elasticity of demand for fruits and vegetables. If a study estimated demand parameters for both low-income consumers and all consumers, we included estimates for the 2 groups.

Methodological Variation of Studies

Our goal was not to review methodological details of food demand system estimation, which are available in other reviews,[15–17] but rather to distill from the existing literature food demand parameters that can be useful to the public health community. In doing so, we accounted for variations in methods and data, which affect individual parameters and may have implications for synthesized average estimates. We segmented studies into 3 mutually exclusive categories based on type of data in estimation: time series, household surveys, and retail scanner data.

Time series data were represented by monthly, quarterly, or annual data on food prices, consumption, and expenditures over time (derived from the USDA and the US Department of Commerce). Survey data were taken from cross-sectional national household surveys (e.g., Nationwide Food Consumption Survey, National Food Stamp Program Survey). More recent studies have often involved retail scanner data from commercial providers (e.g., ACNielsen) that track supermarket transactions. We excluded estimates from laboratory experiments, which could change real-world price sensitivity among customers. We also considered the type of demand system estimation model used.

Consumer demand is a function of multiple factors in addition to prices, including product quality, advertising, preferences, and other demand shift variables. Several studies included advertising in their model or provided quality-adjusted and unadjusted elasticity estimates, which we combined because we had insufficient power to consider them separately. We included a decade of data collection, using the median time point for data over multiple decades.

We pooled estimates of price elasticities across studies by food category (if at least 10 studies were available) and computed ranges and means (along with their 95% confidence intervals) for 16 food and beverage categories: beef, cereal, cheese, dairy products, eggs, fats and oils, fish, food away from home (including fast food and restaurant meals), fruit, juice, milk, pork, poultry, soft drinks, sugars and sweets, and vegetables. We had limited statistical power to synthesize estimates for other foods of interest, including fresh fruits and vegetables, fast food, snacks, and candy.

RESULTS

In the sections to follow, we describe the existing US-based studies involving food demand analyses, provide summary estimates of price elasticities for major food categories, and consider variation in estimates across studies.

Description of Available Literature

We identified 464 relevant citations in our literature search. After all selected articles had been retrieved and reviewed, 184 studies with data on food price elasticity remained. We excluded 5 international studies, 4 review articles, 3 studies involving experimental data, and 12 studies with brand-level food price elasticities, leaving 160 studies in our review (a list of these 160 studies is available on request).

Time series data were used in most studies (99 studies, or 62%), followed by household survey data (34 studies, or 21%) and scanner data (27 studies, or 17%). Only 38 studies were published before 1970. Despite increasing interest in the topic, only 9 studies estimated food price elasticities specifically for low-income groups, with 3 studies examining a broad range of foods.[18–20] Consumer demand for meat, particularly beef and pork, has received substantially greater attention than demand for any other food. Of the 160 studies, 31% provided price elasticity estimates for beef; 29% for pork; 14% for poultry; and 10% for fish. Fewer studies provided estimates for milk (15%), cereal (12%), cheese (12%), and fruits or vegetables (11%). For example, we identified only 6 estimates for fresh fruits and vegetables as a combined category (not including studies focusing on individual vegetables or fruits). Other foods were considered in less than 10% of all reviewed studies.

Price Elasticity Estimates

Mean price elasticity estimates for the 16 food and beverage groups considered, along with their 95% confidence intervals and ranges, are presented in Table 1. Overall, our results are consistent with customary characterizations of the demand response to food prices as inelastic; all mean price elasticity estimates were below 1.0 and ranged from 0.27 to 0.81 (all elasticity estimates here and throughout the text are absolute values). Estimates were relatively less inelastic for soft drinks (0.79), juice (0.76), meats (0.68–0.75), fruit (0.70), and cereals (0.60) and most inelastic for eggs (0.27), sugars and sweets (0.34), cheese (0.44), and fats and oils (0.48). Food away from home was

TABLE 1—US Price Elasticity Estimates, by Food and Beverage Category, from 1938–2007

Food and Beverage Category[a]	Absolute Value of Mean Price Elasticity Estimate (95% CI)	Range	No. of Estimates
Food away from home	0.81 (0.56, 1.07)	0.23–1.76	13
Soft drinks	0.79 (0.33, 1.24)	0.13–3.18	14
Juice	0.76 (0.55, 0.98)	0.33–1.77	14
Beef	0.75 (0.67, 0.83)	0.29–1.42	51
Pork	0.72 (0.66, 0.78)	0.17–1.23	49
Fruit	0.70 (0.41, 0.98)	0.16–3.02	20
Poultry	0.68 (0.44, 0.92)	0.16–2.72	23
Dairy	0.65 (0.46, 0.84)	0.19–1.16	13
Cereals	0.60 (0.43, 0.77)	0.07–1.67	24
Milk	0.59 (0.40, 0.79)	0.02–1.68	26
Vegetables	0.58 (0.44, 0.71)	0.21–1.11	20
Fish	0.50 (0.30, 0.69)	0.05–1.41	18
Fats/oils	0.48 (0.29, 0.66)	0.14–1.00	13
Cheese	0.44 (0.25, 0.63)	0.01–1.95	20
Sweets/sugars	0.34 (0.14, 0.53)	0.05–1.00	13
Eggs	0.27 (0.08, 0.45)	0.06–1.28	14

Note. Values were calculated based on the 160 studies reviewed. Absolute values of elasticity estimates are reported. The price elasticity of demand measures the percentage change in purchased quantity or demand with a 1% change in price.
[a]Including restaurant meals and fast food.

most responsive to changes in prices among other categories (0.81) and more elastic than demand for food at home (0.59; however, the latter value is based on 7 studies).

Milk was the most studied category aside from meat (26 estimates). Thirteen studies provided elasticity estimates for specific milk fat levels. Mean elasticities for skim, 1%, and whole milk ranged from 0.75 to 0.79, whereas the mean elasticity for 2% milk was 1.22.[21–33] Understanding differences in price elasticity for different types of milk and cross-price elasticity for milk with varying fat content is important in food policy analyses that examine approaches to reducing saturated fat consumption (as recommended in the Dietary Guidelines for Americans).

Because milk is among the 3 leading sources of saturated fat in the American diet, substitution away from whole milk toward milk with lower fat content is one promising avenue for dietary change.[13] We identified 5 studies that evaluated cross-price elasticities for milk with varying fat content.[22,26,27,30,32] For a 10% increase in the price of whole milk, increases in purchased quantities ranged between 0.6% and 5% for low-fat or reduced-fat milk and between 0.1% and 2.9% for skim milk. Thus, consumers are more likely to switch to reduced or low-fat milk than skim milk when the price of whole milk increases.

Only a small number of studies evaluated the effects of income level on demand elasticity, and thus we were not able to identify consistent differences in estimated price elasticities between low-income consumers and consumers as a whole. Of the 9 studies reporting price elasticity estimates for low-income populations, 7 presented data for both low-income and all consumers. One study focusing on milk demand showed that demand was more price elastic in low-income populations (1.2 versus 0.66), and a study on fast food depicted a large difference as well (2.09 versus 0.51).[34,35] However, 3 studies including estimates for a broader group of foods reported essentially no difference, with average elasticities of 0.62 for low-income populations and 0.64 for consumers as a whole.[18,20,36]

Of particular importance to policymakers, the available estimates of food price elasticity offer little guidance on a number of key food categories included in the Dietary Guidelines for Americans. Many of the studies reviewed focused on aggregate food categories, with little (if any) consideration for disentangling healthier and less healthy options within categories. Specifically, in the case of many key foods in the Dietary Guidelines for Americans, we did not identify any studies that estimated price elasticities, including cross-price elasticities, to predict within-category shifts between healthier and less healthy alternatives. These foods included whole grain products as well as substitutions between brown and white rice, baked and regular chips, lean and regular types of meat, and reduced-fat and regular cheese.

Although the public health community is attempting to increase people's intake of whole grains, existing research offers no data to predict price-induced shifts in purchases of whole grain products. We found no estimates of how quantities of whole wheat bread purchased would react to changes in the price of refined flour bread. Only 1 study estimated price elasticities for diet and regular soft drinks,[28] and the authors did not offer cross-price elasticities (although a number of brand-level studies have examined substitutions between specific brands of diet and regular soft drinks). One study estimated price elasticities for snack food and candy, and 2 studies offered estimates for fast food.[28,37,38] Despite an increasing focus on nutrient density, we did not identify any studies with elasticity estimates for specific nutrients such as saturated fat.

Sensitivity of Estimates Across Studies

For virtually all estimated demand functions, there is evidence of persistence in food purchasing behavior. For beef, the most commonly analyzed food in our review, we found little variation in elasticity estimates across study designs. Type of demand model, data, peer review status (i.e., peer review versus no peer review), study size (multiple versus single

categories of foods), and time of data analysis were not significantly related to the estimates in beef analyses (either jointly in F tests or individually in *t*-test comparisons). Similarly, the estimated parameters for pork, cheese, and vegetables did not vary significantly according to study methodology. There was some variation in how type of demand system model and data affected estimates in studies on milk, fruit, and fish. However, because of the smaller number of data points (e.g., 18 for fish and 26 for milk versus 51 for beef), these findings must be interpreted with caution.

Given the heightened interest of legislators in the soft drink category and the importance of estimating price elasticity of demand for soft drinks to forecast tax effects, we calculated alternate elasticity estimates based on different assumptions or definitions of soft drinks as a product. The mean price elasticity for the soft drink category (0.79, absolute value) was based on 14 estimates in which definitions of the category varied; category definitions included soft drinks, carbonated soft drinks, juice and soft drinks, soda, soda and fruit ades, nonalcoholic beverages, other beverages (all nonalcoholic beverages excluding milk and juices), and, in 1 study, beverages (the exclusion of this final study had essentially no effect on the mean estimate, increasing it from 0.79 to 0.82).

In a more conservative approach to defining the category of soft drinks, we included 7 studies with estimates for soft drinks, carbonated soft drinks, soda, and soda or fruit ades, with a mean price elasticity of 1.00. Further restricting the definition of soft drinks limited the number of available studies for review. Only 2 estimates were available for carbonated soft drinks (1.08)[39] and soda (0.58),[40] along with 1 study with a combined estimate for soda and fruit ades (1.10)[41] and 1 study with separate regular soft drink (1.05) and low-calorie soft drinks (1.26) estimates.[28] Excluding working papers and the single dissertation resulted in a mean price elasticity of demand for soft drinks of 0.93.

DISCUSSION

Considerable data are available on price elasticities of demand for certain foods. We found mean price elasticity estimates ranging from 0.27 to 0.81 (absolute values), with the highest price elasticities for food away from home, soft drinks, juice, meats, and fruit and the most inelastic demand for eggs. Higher elasticity estimates suggest greater changes in population purchases as prices shift. From a public health perspective, more elastic demand for food is encouraging if change in demand is a priority (e.g., decreased intake of sugar-sweetened beverages and increased consumption of fruits and vegetables). Such data help bridge the public health and economics communities and begin to establish a vision of where price changes might have the greatest impact on consumer food choices, nutrition, and health.

Although economists have published extensively on the effects of price changes on commodity- and brand-level demand for foods and beverages, substantial gaps in the research base exist. These gaps must be filled to gain a more complete understanding of the public health impact of policies that realign food prices. The studies we reviewed did not assess the effects of price changes on substitutions from unhealthy to healthy food choices for many of the key categories (e.g., whole grains) in the Dietary Guidelines for Americans, which are targets in public health campaigns. There is some evidence to suggest that low-income populations may be more sensitive to price changes than the overall population.[3] Still, current data on the role of income are rather limited, and assessments of differences in responsiveness to food prices according to age, education, culture, or ethnicity are not available.

The effects of cigarette taxes on smoking prevalence demonstrate the significant potential of tax policies to modify purchasing behavior.[4] The public health benefit of even moderate price increases for unhealthy foods can be compared with the demand effect of moderate changes in the price of cigarettes. For example, a negligible change in the price of cigarettes (0.03% of weekly earnings) reduced smoking prevalence by 0.3% among Australian adults.[42] In contrast, the World Health Organization concluded that large tax increases have been the most effective policy for reducing tobacco use.[43] In addition, studies of cigarette taxation suggest that young people may be more responsive to price changes and taxes than the adult population.[44] This is an important consideration in evaluating the potential effects of food tax or subsidy policies on children's food purchases and childhood obesity.

Food Policy Implications

As a result of their negative effects on nutrition and their current taxation status, soft drinks offer a possible target for public health tax policies.[1,45] On average, sugar-sweetened beverages contribute 301 kcal (1260 kJ) per day per capita (13% of total daily energy values) to the diets of American adolescents.[46] Assuming no substitution of soft drinks with other caloric beverages and no change in other factors affecting purchasing behavior, our estimates of the price elasticity of soft drinks suggest that a 10% tax on soft drinks could lead to an 8% to 10% reduction in purchases of these beverages.

Small changes add up. One USDA study that estimated potential weight loss from various tax rates on salty snacks under a range of price elasticities predicted that a 10% price increase from a national sales tax could reduce body weight between 0.2 and 0.99 lb (0.1–0.5 kg) per year while generating approximately $1 billion in tax revenue.[47] State governments already target sales taxes at soft drinks and selected snack foods. As of January 2009, 33 states taxed the sale of soft drinks at an average rate of 5.2%.[48] Of importance to policymakers, recent surveys show that the public is willing to pay increased taxes if the funds generated are used to address childhood obesity.[49,50]

Although the potential public health benefits of price changes in specific food categories can be estimated, it is essential to assess changes in consumer behavior as price changes occur. For example, in the event of higher prices resulting from increased taxes, consumers could increase their caloric consumption from fruit juice to compensate for their reduction in soft drink intake, or, more positively, they might generalize the healthy changes they make to other categories of foods. It is also important to consider how governments use revenues generated by changes in economic policies such as taxes. For instance, regressive food taxes could be offset by using revenues to lower the costs of healthy foods, particularly for low-income population groups.

Such policies are under consideration. The Food, Conservation and Energy Act of 2008 (known as the "Farm Bill") authorized a $20 million pilot study examining the use of price incentives to promote consumption of fruits, vegetables, and other healthy foods among food stamp recipients.[11] On the basis of our mean price elasticities of 0.70 for fruits and 0.58 for vegetables, a 10% reduction in the price of these foods would increase purchases on average by 7.0% and 5.8%, respectively.

As such, changes in prices alone would probably not increase consumption of fruits and vegetables to the levels recommended in the Dietary Guidelines for Americans. However, price changes combined with public education campaigns and other regulations affecting the food environment in institutional and home settings may have a multiplicative effect that could significantly improve diets, particularly among at-risk population groups. Although demand for food is relatively inelastic, the power of small price changes, especially applied to foods most responsive to such changes, should not be underestimated given that their effects accumulate across a population.

Our review had limitations. For example, we used combined estimates of price elasticity for fruits and vegetables (which were the only available estimates in many studies), and thus we may have underestimated the separate price elasticities of demand for fruits and vegetables. In addition, none of the studies included in our review were published after September 2007 (when we completed the review). Finally, our synthesis of estimates was a simplified calculation of means rather than a meta-analysis, which could not be conducted given the lack of elasticity estimate standard errors in the literature.

Conclusions

Economic shocks such as falling income in a recession or dramatic increases in energy or food prices can lead to changes in purchasing behavior that are not necessarily predicted by elasticity estimates calculated with data collected under normal market conditions. It is important to understand the effects of such economic circumstances on diet quality, particularly in low-income groups. The fear is that increasing food prices or falling incomes in a recession create pressure to purchase the foods lowest in cost, which makes processed, calorie-dense foods more attractive. Given the relative consensus in the economic community about the magnitude of food price elasticities and the observed gaps in research related to substitutions between healthy and unhealthy foods, future research should focus on predicting the impact of specific public health policies aimed at improving diets and reducing the burden of chronic disease. ■

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Contributors

T. Andreyeva and M. W. Long conducted the literature review and extracted, synthesized, and analyzed data. T. Andreyeva and K.D. Brownell originated the study. T. Andreyeva led the data interpretation and the writing of the article. All of the authors helped to conceptualize ideas and interpret findings and contributed to the writing and revision process.

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Human Participant Protection

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References

1. Brownell KD, Frieden TR. Ounces of prevention—the public policy case for taxes on sugared beverages. *N Engl J Med.* 2009;360(18):1805–1808.

2. Guthrie J, Frazao E, Andrews M. Improving food choices—can food stamps do more? *Amber Waves.* April 2007: 22–28.

3. Powell LM, Chaloupka FJ. Food prices and obesity: evidence and policy implications for taxes and subsidies. *Milbank Q.* 2009;87(1):229–257.

4. Jha P, Chaloupka FJ, Corrao M, Jacob B. Reducing the burden of smoking world-wide: effectiveness of interventions and their coverage. *Drug Alcohol Rev.* 2006;25(6):597–609.

5. Epstein LH, Dearing KK, Paluch RA, Roemmich JN, Cho D. Price and maternal obesity influence purchasing of low- and high-energy-dense foods. *Am J Clin Nutr.* 2007;86(4):914–922.

6. French SA. Pricing effects on food choices. *J Nutr.* 2003;133(3):841S–843S.

7. Herman DR, Harrison GG, Afifi AA, Jenks E. Effect of a targeted subsidy on intake of fruits and vegetables among low-income women in the Special Supplemental Nutrition Program for Women, Infants, and Children. *Am J Public Health.* 2008;98(1):98–105.

8. Horgen KB, Brownell KD. Comparison of price change and health message interventions in promoting healthy food choices. *Health Psychol.* 2002;21(5): 505–512.

9. *Revisions in the WIC Food Packages: Interim Rule.* Washington, DC: US Dept of Agriculture; 2007.

10. Jacobson MF, Brownell KD. Small taxes on soft drinks and snack foods to promote health. *Am J Public Health.* 2000;90(6):854–857.

11. HR 2419 (2008).

12. Chriqui JF, Eidson SS, Bates H, Kowalczyk S, Chaloupka FJ. State sales tax rates for soft drinks and snacks sold through grocery stores and vending machines, 2007. *J Public Health Policy.* 2008;29(2):226–249.

13. *Dietary Guidelines for Americans 2005.* Washington, DC: US Dept of Agriculture; 2005.

14. Pindyck RS, Rubinfeld D. *Microeconomics.* 4th ed. Englewood Cliffs, NJ: Prentice Hall Inc; 1998.

15. Johnson SR, Hassan ZA, Green RD. *Demand Systems Estimation: Methods and Applications.* Ames, IA: Iowa State University Press; 1984.

16. Raunikar R, Huang CL. *Food Demand Analysis: Problems, Issues, and Empirical Evidence.* Ames, IA: Iowa State University Press; 1987.

17. Wohlgenant MK. Conceptual and functional form issues in estimating demand elasticities. *Am J Agric Econ.* 1984; 66(2):211–215.

18. Huang KS, Lin B. *Estimation of Food Demand and Nutrient Elasticities From Household Survey Data.* Washington, DC: US Dept of Agriculture; 2000.

19. Yen ST, Lin BH, Smallwood DM. Quasi- and simulated-likelihood approaches to censored demand systems: food consumption by food stamp recipients in the United States. *Am J Agric Econ.* 2003;85(2):458–478.

20. Park JL, Holcomb RB, Raper KC, Capps O Jr. A demand systems analysis of food commodities by US households segmented by income. *Am J Agric Econ.* 1996;78(2):290–300.

21. Glaser LK, Thompson GD. Demand for organic and conventional beverage milk. Paper presented at: Annual Meeting of the Western Agricultural Economic Association; June 29- July 1, 2000; Vancouver, British Columbia, Canada.

22. Gould BW. Factors affecting US demand for reduced-fat fluid milk. *J Agric Resour Econ.* 1996;21(1):68–81.

23. Green GM, Park JL. Retail demand for whole vs. low-fat milk: new perspectives on loss leader pricing. Paper presented at: Annual Meeting of the American Agricultural Economics Association; August 2-5, 1998; Salt Lake City, UT.

24. Green GM, Park JL. New insights into supermarket promotions via scanner data analysis: the case of milk. *J Food Distrib Res.* 1998;29(3):44–53.

25. Kaiser HM, Reberte JC. Impact of generic advertising for fluid milk on demand for whole, lowfat, and skim milks. *J Dairy Sci.* 1996;79(12):2284–2291.

26. Maynard LJ. Empirical tests of the argument that consumers value stable retail milk prices. *J Agribusiness.* 2000; 18(2):155–172.

27. Chouinard HH, Davis DE, LaFrance JT, Perloff JM. *The Effects of a Fat Tax on Dairy Products.* Berkeley, CA: University of California; 2005.

28. Bergtold J, Akobundu E, Peterson EB. The FAST method: estimating unconditional demand elasticities for processed foods in the presence of fixed effects. *J Agric Resour Econ.* 2004;29(2): 276–295.

29. Schmit TM, Chung C, Dong D, Kaiser HM, Gould B. *Identifying the Extensive and Intensive Effects of Generic Advertising on the Household Demand for Fluid Milk and Cheese.* Ithaca, NY: Cornell University; 2001.

30. Gould BW, Cox TL, Perali F. The demand for fluid milk products in the United States: a systems approach. *West J Agric Econ.* 1990;15(1):1–12.

31. Boehm WT. The household demand for major dairy products in the southern region. *South J Agric Econ.*1975(Dec);7: 187–196.

32. Yen ST, Lin BH, Smallwood DM, Andrews M. Demand for nonalcoholic beverages: the case of low-income households. *Agribusiness.* 2004;20(3): 309–321.

33. Schmit TM, Dong D, Chung C, Kaiser HM, Gould BW. Identifying the effects of generic advertising on the household demand for fluid milk and cheese: a two-step panel data approach. *J Agric Resour Econ.* 2002;27(1):165–186.

34. Bartlett RW. Fluid milk sales related to demand elasticities. *J Dairy Sci.* 1965; 47(12):1314–1321.

35. Barnes R, Gillingham R. Demographic effects in demand analysis: estimation of the quadratic expenditure system using microdata. *Rev Econ Stat.* 1984; 66(4):591–601.

36. Raper KC, Wanzala MN, Nayga RM Jr. Food expenditures and household demographic composition in the US: a demand systems approach. *Appl Econ.* 2002;34(8):981–992.

37. Brown MG. The restaurant and fast food race: who's winning? *South J Agric Econ.* 1990;56(4):984–995.

38. Jekanowski MD, Binkley JK, Eales J. Convenience, accessibility, and the demand for fast food. *J Agric Resour Econ.* 2001;26(1):58–74.

39. Pittman GF. *Drivers of Demand, Interrelationships, and Nutritional Impacts Within the Nonalcoholic Beverage Complex* [dissertation]. College Station, TX: Texas A&M University; 2004.

40. Heien DM, Wessells CR. The demand for dairy products: structure, prediction, and decomposition. *Am J Agric Econ.* 1988;70(2):219–228.

41. Heien DM, Wessells CR. Demand systems estimation with microdata: a censored regression approach. *J Bus Econ Stat.* 1990;8(3):365–371.

42. Wakefield MA, Durkin S, Spittal MJ, et al. Impact of tobacco control policies and mass media campaigns on monthly adult smoking prevalence. *Am J Public Health.* 2008;98(8):1443–1450.

43. *WHO Report on the Global Tobacco Epidemic, 2008: The MPOWER Package.* Geneva, Switzerland: World Health Organization; 2008.

44. Chaloupka FJ, Wechsler H. Price, tobacco control policies and smoking among young adults. *J Health Econ.* 1997;16(3):359–373.

45. Vartanian LR, Schwartz MB, Brownell KD. Effects of soft drink consumption on nutrition and health: a systematic review and meta-analysis. *Am J Public Health.* 2007;97(4):667–675.

46. Wang YC, Bleich SN, Gortmaker SL. Increasing caloric contribution from sugar-sweetened beverages and 100% fruit juices among US children and adolescents, 1988–2004. *Pediatrics.* 2008;121(6):e1604–e1614.

47. Kuchler F, Tegene A, Harris J. *Taxing Snack Foods: What to Expect for Diet and Tax Revenues.* Washington, DC: US Dept of Agriculture; 2004.

48. Chaloupka FJ, Powell LM, Chriqui JF. Sugar-sweetened beverage taxes and public health. *RWJF Research Brief.* 2009. Available at: http://www.rwjf.org/pr/product.jsp?id=45828. Accessed December 2, 2009.

49. Cawley J. Contingent valuation analysis of willingness to pay to reduce childhood obesity. *Econ Hum Biol.* 2008; 6(2):281–292.

50. Oliver JE, Lee T. Public opinion and the politics of obesity in America. *J Health Polit Policy Law.* 2005;30(5):923–954.