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The impacts of inclusive and exclusive taxes on healthy eating: An experimental study

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ABSTRACT

Based on a laboratory experiment conducted with 131 adults (non-students subjects), we empirically examine the differential impacts of an inclusive and exclusive tax on changing consumers' eating behavior. We compare the caloric and nutrient content of the meals selected by the subjects using a difference-in-difference regression model to determine the efficacy of the policy treatments. The results indicate that an inclusive tax has a significantly stronger effect on reducing the consumption of total calories, calories from fat, and the intake of carbohydrates, cholesterol, sugar and sodium compared with an exclusive tax.

Introduction

Obesity among U.S. adults has reached epidemic proportions. As reported in 2013, the adult obesity rate in the United States is 34.9% (Centers for Disease Control and Prevention, 2014). The prevalence of obesity among middle-aged adults was 39.5% in the United States in 2011–2012 (Ogden and Carroll, 2010). According to the Centers for Disease Control and Prevention (2014), obesity is a major risk factor for a number of chronic diseases, including heart disease, stroke, type II diabetes and certain types of cancer. One study estimates that the current direct and indirect costs of obesity are more than $190 billion annually in the United States (Institute of Medicine [IOM], 2012). The Centers for Disease Control and Prevention (2014) states that the fundamental cause of people being overweight or obese is an energy imbalance between calories consumed and expended, and an increased intake of foods that are high in fat is undoubtedly one of the major contributions.

In order to reduce obesity, economic incentives/disincentives have been considered, and in some cases implemented, to promote healthy diets. Chief among these policies is a tax on unhealthy foods. The Rudd Center for Food Policy and Obesity at Yale suggest two methods for raising prices of unhealthy foods: (1) tax foods with poor nutrients profiles; and (2) tax broader categories of unhealthy food and beverages, such as carbonated drinks and snacks. Most of the states and cities in the United States implementing tax policies to fight obesity have adopted the first method and levied taxes on the soft drink category. For example, supervisors in San Francisco, California introduced a 2-cents-per-ounce tax on sugary drinks sold in the city, and lawmakers in Berkeley, California adopted a 1-cent-per-ounce tax on sugary drinks in 2014. A second method of levying an unhealthy food tax (also known as a "fat tax") has also been discussed, proposed, and even implemented in several countries. In 2011, Denmark imposed the world's first fat tax on foods with more than 2.3% saturated fats; but the policy was abolished in 2012 (Jensen and Smed, 2013). These food taxes are collected in the form of a higher sales tax rate compared to the regular food tax rate, or an additional excise tax. Among the thirty-three states in the United States that levy taxes on soft drinks, twenty-five of them apply only the sales tax to the category, one applies only an excise tax, and seven apply both excise and sales taxes (Zheng et al., 2013).

The difference between a sales and an excise tax is key to understanding how they induce different consumer behaviors. The fundamental difference is whether the tax is levied at the point of production or the point of sale. An excise tax is levied at the point of production (e.g., wholesale or manufacturing-level), and it is added to the posted-price of the product. Therefore, excise taxes are expressed in tax-inclusive terms, which refer to the amount of tax paid as a proportion of the after-tax value. Virginia, in addition to having a sales tax, also imposes a state excise tax on soda, which is an example of inclusive tax. Alternatively, a sales tax can be either inclusive or exclusive. For example, in the United States, the sales tax on clothing and food items in grocery stores and restaurants is generally not reflected

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by the posted-price, but rather is added at the register upon check-out. Consequently, sales taxes on these items are typically expressed in tax-exclusive terms (Tax Policy Center, 2012; Chetty et al., 2009; Zheng et al., 2013).[1] A tax-exclusive tax rate refers to the amount of tax paid as a proportion of the pretax value of whatever is taxed.

An exclusive tax typically has lower salience than an inclusive tax. The economic literature has investigated and compared the efficacy of these two types of taxes. Miao et al. (2012) suggest that both a sales tax on sweetened goods and a sweetener input tax can reduce added sweetener consumption, but the latter policy causes about five times less consumer surplus loss than the former. Chetty et al. (2009) find that consumers tend to under-react to taxes that are not included in posted prices because of the difficulty in computing the gross after-tax price. Relatedly, Zheng et al. (2013) focus on the effect of imperfect tax knowledge, and conclude that a sales tax (i.e., exclusive tax) change does not reduce demand as much as an excise tax (i.e., inclusive tax) change of the same magnitude. While these and other studies are useful in understanding tax salience, there is an absence of empirical research on the impact of applying the taxes on food and beverage demand.

Accordingly, the goal of this research is to empirically study the impact of exclusive and inclusive taxes on nutrient composition of a meal selection. To our knowledge, no earlier work has compared how these two types of taxes impact the nutrient content of a meal selection. As defined by Chetty et al. (2009), the "salience" of a tax indicates the simplicity of calculating the gross-of-tax price of a good. To achieve our goal, we designed a controlled laboratory experiment conducted with 131 adult, non-student subjects that were asked to select lunch items from a cafeteria menu. Each subject was randomly assigned to a control group or one of the two treatments: (1) 20% inclusive tax on unhealthy foods and beverages and (2) 20% exclusive tax on unhealthy foods and beverages. We examine taxes that are levied on unhealthy foods. A difference-in-difference regression model is used to determine the efficacy of the various policy treatments on the intake of calories, fat, sugar, cholesterol, and sodium. The results confirm our hypothesis that while both taxes reduce caloric and other nutrient intake, an inclusive tax has a more significant impact on consumers' eating behavior, calorie consumption, and nutrient intake than an exclusive tax.

The remainder of the paper is organized as follows: the second section summarizes the related literature. This is followed by a discussion of the experimental design of the study. The fourth section presents the empirical model, and discusses the estimation results. The fifth section discusses the implications of the study's findings. The last section summarizes the conclusions of the study.

An overview on the debate over fat taxes

The idea of levying an "overweight fee" dates back to 1940s (Engber, 2009), but was not well known until the 1980s when Dr. Brownell proposed that revenue from junk-food taxes be used to subsidize more healthful foods and fund nutrition campaigns, and only recently has spurred a debate in the literature. Some members of the scientific community, including public health advocates, have emphasized that fat taxes are important too and should be considered in the public policy arena. Brownell (1994) argued that healthy foods cost more than unhealthy foods in a New York Times, Op-Ed piece and proposed the concept of a "fat tax". Since then, the idea of adopting food tax policies to combat obesity has been discussed worldwide, and in some cases has been implemented.

Kim and Kawachi (2006) and Powell and Chaloupka (2009) find that changes in the relative prices of healthy and unhealthy foods impact consumption patterns and have the capacity to lower obesity levels. Brownell and Frieden (2009) argue that taxes on fattening foods have three justifications: (1) the contribution of unhealthful diets to the illnesses cited previously creates an externality to health care costs; (2) food nutritional information is asymmetric between consumers and food firms; and (3) the revenue generated from such taxes can increase societal benefits by promoting healthy diets. They believe that a tax on sweetened beverages would encourage consumers to switch to more healthful beverages and hence reduce caloric intake. Along similar lines, Chaloupka et al. (2011a) argue that a sizeable tax on sugar-sweetened beverages would not only lead to a significant reduction in calorie intake, but would also generate significant new revenues that can be used to support obesity prevention efforts. Chaloupka et al. (2011b) furthermore argue that the revenue generated by such a tax would further enhance the effectiveness of a large tax on sweetened beverages. Fletcher et al. (2011a) argue that policymakers can improve health outcomes further by expanding the scope of the tax to include all calorie-dense foods (beyond sugar-sweetened beverages).

However, these results are not universally accepted in the literature, and there is growing evidence from economists showing that fat taxes have limited effectiveness in the marketplace, and have highlighted that there may be unintended consequences from using such instruments. Cash and Lacanilao (2007) suggest that the economic evidence on food price interventions to improve healthy diets is far from complete, and that the full impact of such policies is unclear. Chouinard et al. (2007) argue that fat taxes are extremely regressive, and would cause greater welfare losses on the elderly and poor. Similarly, Engber (2009) contends that a fat tax would fall disproportionately on poorer people who tend to consume more fattening food and who are more sensitive to price. Gandel (2014) casts doubt on the efficacy of taxing unhealthy food, suggesting that taxes have little impact on altering consumer behavior.

Among the supporters of fat tax policies, the question of which stage, production or sale, should the tax be levied at has attracted much attention. Engelhard et al. (2009) argue that although an "upstream" tax can avoid administrative complications for stores, a sales (exclusive) tax has countervailing advantages, including generating revenue that rises with inflation, and allowing for a short-term tax exemption. Brownell and Frieden (2009), however, point out that by levying tax as a percentage of the retail price, sales tax policies would actually encourage the purchase of larger containers at a lower unit price; while an excise tax structured as a fixed cost per ounce would be more effective in reducing consumption. The authors also indicate that as manufacturers pass the excise tax along to customers, the amount of the tax would be included in the price consumers see when making selection, and therefore cause a greater drop in consumption than a sales tax.

In order to examine how an exclusive tax such as a sales tax would lead to sub-optimizing shopping behavior, Chetty et al. (2009) conduct an experiment and an observational study, according to which they conclude that salience is an important determinant of the effect of a tax. To explain their empirical findings, they introduce small cognitive costs into a neoclassical model of consumer choice and show that such costs can significantly affect the welfare consequences of tax policies. Likewise, Feldman and Ruffle (2015) show based on data generated from a lab experiment that people buy more under a tax-exclusive regime than under an

[1] The focus of this analysis is on exclusive versus inclusive taxes. While some have used the term "sales tax" synonymously with "exclusive tax," some countries/regions such as the European Union, New Zealand, and Australia include "sales taxes" in their posted prices on the shelf. To avoid confusion over our terminology, throughout the rest of the article, we use the terms "exclusive" and "inclusive" taxes rather than "sales" and "excise" taxes.

equivalent tax-inclusive regime. Zheng et al. (2013) focus on food and beverage demand, and develop a theoretical framework to examine the effect of a change in inclusive or exclusive taxes. They assume that while consumers have good knowledge of the tax rate, they are sometimes inattentive to exclusive taxes, and may have misperception of the tax status (i.e., whether an item is taxable) of some items. They find that although both the effects of an exclusive tax and an inclusive tax are influenced by imperfect tax knowledge, the effect that an inclusive tax change has on demand is largely comparable with that of a price change, while an exclusive tax fails to affect demand as much as an inclusive tax of the same magnitude.

While these studies provide a solid theoretical foundation and empirical evidence on the effect of tax salience on consumer demand, the research summarized here outlines the scarce amount of empirical work studying the impact of tax salience on healthy eating behavior. The purpose of this research is to conduct a luncheon experiment to provide empirical evidence for the conclusions drawn from the theoretical model of Zheng et al. (2013). This is the first paper, to our knowledge, to examine the impact of tax salience of these two types of taxes concentrating on healthy and unhealthy food nutrient content using data generated from a controlled laboratory experiment. The structure of the experiment is described below.

Experimental design

The experiment was conducted in the United States at Cornell University in Ithaca, New York. A total of 131 adult non-student subjects, recruited from a university staff website, participated in the economic experiment. They were randomly assigned into three groups, including one control group and two treatments. Subjects were paid $20 cash, plus a $10 voucher that could be spent on food items that they selected from the lunch menu used in the experiment.[2] The lunch menu contained food items in three main categories: beverages, entrée and snacks. Each category consisted of relatively healthy (e.g., veggie cup) and unhealthy (e.g., cheeseburger) items.[3]

Each subject viewed two menus that were similar to the one used by Streletskaya et al. (2014), but included 11 additional items. The first menu presented the base prices that were the same across the control and two treatment groups. The prices on the second menu varied by treatment (see the full list of food items and prices on each menu in Appendix A.1).

There were two parts in the experiment. In each part, subjects were asked to select food and beverage items from a lunch menu presented to them in the course of the experiment. They were told they could use the $10 endowment of vouchers and the $20 participation fee to pay for their lunch selections. The participants were told that they would complete a series of menus and that one of the completed menus was randomly drawn before the start of the experiment, and that the choice of lunch food items on this particular menu would be the one that they would receive their chosen items from and be charged. This process was followed to insure that subjects paid serious attention to food and beverage selection for both menus presented to them in the experiment. Subjects were informed that if they spent less than $10 on the drawn menu, they would not receive the excess in cash, and if they spent over $10, they would need to use part of their $20 cash payment in addition to the $10 endowment to pay for the selected items on the drawn menu.

In Part 1 of the experiment, all subjects were asked to select lunch items from menu A. Prices on menu A were the same for subjects in the control and the two treatment groups. In Part 2 of the experiment, the control group was presented with the exact same menu as menu A, while the two treatment groups were provided with different menus.

Treatment I

Inclusive tax treatment

Subjects in this group were provided menu B in this part, where the prices of unhealthy items were increased by a 20% inclusive tax, while prices of other items remained the same as on menu A. We included a note at the top of subjects' computer screens that stated: "A 20% 'unhealthy food' excise tax has been added to the price of unhealthy food and beverages."

Treatment II

Exclusive tax treatment

Subjects in this group were provided menu C in this part, where prices of all items were the same as on menu A, but with the following note on top of the screen: "A 20% 'unhealthy food' sales tax will be added to your purchase when you check out." Subjects in this treatment were not informed which specific foods were taxed, only that "unhealthy foods" would be taxed. This was done to mirror how such taxes would be implemented in the real world. For example, if the government put an exclusive tax on all products with a sodium content higher than some threshold, consumers would not be told at the grocery store which specific products this tax applies to. Typically, grocery stores and restaurants in the U.S. have exclusive taxes on food items, meaning the tax is not included in the shelf price, but rather is added to the total bill at checkout.

During the experiment, participants in the control group were not informed of the taxes at all, and subjects in the two treatments were not presented information about the tax until the beginning of Part 2. We stated the tax rate in both written and oral instruction, but did not specify which items were taxable.

For subjects in the control group and in the two treatment groups, the menus were presented on the computer screen (see Appendix A.3 for the screen shots of menu A, B and C with 4 items chosen on each of them as an example, as well as the check out pages that follow the presentation of the menus). For the control group and treatment I, the total price was presented to them at the bottom of the screen. For treatment II, the subtotal price before exclusive tax was presented to them at the bottom of the screen, but the after-tax price was not presented to them until they checked out, and they could not return to change their orders. In reality, a consumer could forgo an item if they realized it was taxed and they decided not to purchase it, but for simplicity we assume that this rarely happens in the market.

At the beginning of each part, participants were presented with written and oral instructions on how the computerized menus work. During each part, participants were given ample time to complete their menus. After all parts were completed, participants were asked to complete a computerized questionnaire collecting their demographic information. The complete list of all the questions asked in the computerized survey is presented in Appendix A.4.

[2] The list of food items and prices were from the menu of the campus dining hall where subjects could redeem the voucher and get their selected meals after the experiment.

[3] There are several items that are difficult to classify as either healthy or unhealthy, e.g., a tuna sandwich, which we classified as healthy, could include white bread and mayonnaise. However, the focus here is on the relative impacts of the inclusive versus exclusive tax, and because both treatments have the same items selected as either being taxed or untaxed, this does not impact the results for the two treatments. It is worth noting because deciding on what products to tax or not tax could be problematic in any real world application of an unhealthy food tax policy.

Empirical model

The econometric model we use to examine the impacts of the treatments on caloric intake and nutrient intake is a difference-in-difference (DID) model. As we have data on the same individuals in both pre- and post-periods, the original form of the DID model is applicable:

$$\Delta Y_i = \alpha_0 + \beta_1 D_1 + \beta_2 D_2 + \alpha_1 X_i + \varepsilon_i \quad (1)$$

where ΔY_i is the difference in content of nutrient Y from the first menu to the second menu for individual i. We calculate ΔY_i by summing the nutrient Y's contents in items selected by individual i on each menu, then subtracting the total value of it on the first menu from that on the second menu. The term D_j is a treatment dummy variable, with D_1 indicating the inclusive tax treatment and D_2 indicating the exclusive tax treatment. X_i is a vector of control variables indicating the socioeconomic and demographic characteristics of individual i.

In this study we focus the following nutritional factors based on their importance in the Report of Dietary Reference Intakes (2010) and Dietary Guidelines Advisory Committee Report (Agricultural Research Service (ARS), 2010): calories, empty calories, calorie from fat, carbohydrate, fiber, fat, cholesterol, protein, sugar and sodium. Most of the nutritional information was obtained from the National Agricultural Library of USDA (www.ndb.nal.usda.gov), and the Center for Nutrition Policy and Promotion (CNPP, https://www.supertracker.usda.gov/default.aspx), an organization of USDA. Some nutritional information on beverages was obtained from either the manufacturer's official website (http://www.pepsicobeveragefacts.com/) or the nutritional label on the package.

Results

To test the internal consistency of the control group, we examined whether there was any statistically significant change in any of the nutrients of the meals selected between the first and second menu. There was no statistical difference between menus for the control group. We also examined whether there was any statistical significant difference between menu 1 for the control group and the two treatments by running a difference-in-difference regression between each of the three groups. Again, there was no statistical difference with respect to nutrient content of menu 1 for the three groups.

Table 1 presents the means and standard deviations of the socio-economic and demographic characteristics. Some of the socio-economic and demographic variables statistically significantly affected the intake of some of the nutritional factors. For example, participants with an income level of more than $160,000 consumed fewer calories. Table 2 shows the total caloric consumption of meals selected by participants and the change of total expenditure of all groups. The mean change in calorie content for participants was negative across all groups, and the inclusive tax treatment had the biggest reduction in calorie consumption. Results from *t*-tests show that the demographic variables as well as the change of total expenditure were not significantly different across groups.

Table 3 presents the results from the DID model comparing each treatment with the control group based on the entire menu. We also estimated the DID model in logarithmic form and the results are presented in the Appendix A.5. Here we focus on the linear results, which are qualitatively similar to the logarithmic results.

While both the inclusive and exclusive tax had a negative impact on caloric consumption, only the inclusive tax was statistically significant. Subjects in this treatment consumed 156 fewer calories, which represented a 27.7% decrease in caloric consumption compared to the control group.[4]

As defined by the USDA, empty calories are "calories from food components such as added sugars and solid fats that provide little nutritional value." Measuring empty calories gives us a better understanding of people's intake of food and beverages with actual nutritional value. However, although the inclusive tax had a negative effect on empty calorie content while the exclusive tax did not, neither of these effects was significant. One similar nutrient measure is calories from fat; here only the inclusive tax treatment had a significant negative impact resulting in a 35.5% reduction in calories from fat.

Some other nutritional factors such as carbohydrates, fat, cholesterol, sugar and sodium are also considered undesirable, because they are generally over-consumed and thus are contributing to obesity and other health problems among the U.S. population. Most of these nutritional factors changed significantly in the inclusive tax treatment except for fat. For example, compared to the content of the second menu selection in the control group, subjects in the inclusive tax treatment consumed 13 less grams (49.2%) of sugar and 25 less milligrams (42.4%) of cholesterol, a major determinant of cardiovascular disease and type II diabetes (ARS, 2010). On the other hand, the exclusive tax had no significant impact on the content of these undesirable nutrients except for carbohydrates.

Nutrients such as fiber and protein are considered beneficial in diets (ARS, 2010). Neither of the two treatments showed a significant positive impact on fiber or protein content. In fact, the inclusive tax treatment actually reduced protein by 6 g compared to the control group, and the exclusive tax treatment reduced fiber by 1 g, and both of these effects were statistically significant. There has been research indicating that low protein diets are related to overeating (Gosby et al., 2011), and an increased intake of dietary fiber would be useful for the treatment of obesity (Smith, 1986). Hence, one perverse result in both tax policies is the reduction in the content of such beneficial nutrients.

The model was estimated separately for the three main food categories, and these results are presented in Table 4. In the beverage category, calories, carbohydrates and sugar changed significantly in the inclusive tax treatment, but not in the exclusive tax treatment, which was consistent with the results in Table 3. Calorie content was reduced by 60.7% for beverages. What is worth noting is that the inclusive tax treatment also had a significant negative impact of 9 g (32.9%) on empty calorie content this time, while the exclusive tax treatment continued to have no impact on caloric consumption. That is, an inclusive tax treatment was more effective in reducing the intake of food with little nutritional value than was the exclusive tax.

When considering only the entrée category, calorie content significantly decreased by 122 kcal (25.3%) in the inclusive tax treatment. Nutritional factors that changed significantly were cholesterol and protein in the inclusive tax treatment, with cholesterol content decreasing 29 mg (42.8%), and protein content decreasing by 7 g (27.2%) compared to the control group. The direction of the estimated treatment effect on protein was still opposite from the desired direction.

If we consider the snack category only, none of the nutritional factors changed significantly in either treatment. One potential reason is that, in general, snacks are less necessary for a meal, compared to the other two categories. Taking menu 2 of the control group as an example, 52 subjects chose zero snack items, while only 34 chose zero beverage items and 17 chose zero entrée items. So the tax, whether it is inclusive or not, would have less impact on

[4] Unless otherwise specified, all estimated percentage changes cited in this paper are based on the comparison to second menu selection of the control group, or selections in corresponding food category of the second menu of the control group.

Table 1
Descriptive statistics of selected variables by treatment.

		Treatment			
		All	Control	Inclusive tax	Exclusive tax
Female		0.817	0.825	0.875	0.744
		(0.388)	(0.385)	(0.334)	(0.441)
Age	Less than 20	0.176	0.200	0.146	0.186
		(0.382)	(0.405)	(0.357)	(0.394)
	21–30	0.221	0.250	0.146	0.279
		(0.417)	(0.439)	(0.357)	(0.454)
	31–40	0.344	0.300	0.396	0.326
		(0.477)	(0.464)	(0.494)	(0.474)
	41–50	0.252	0.250	0.312	0.186
		(0.436)	(0.439)	(0.468)	(0.394)
	Over 50	0.008	0	0	0.023
		(0.087)	(0)	(0)	(0.152)
Married		0.481	0.250	0.521	0.419
		(0.502)	(0.439)	(0.505)	(0.499)
Children		1.122	1.150	1.167	1.047
		(1.110)	(1.099)	(1.038)	(1.214)
Race	Caucasian	0.870	0.900	0.875	0.837
		(0.337)	(0.304)	(0.334)	(0.374)
	African American	0.031	0.025	0.021	0.047
		(0.173)	(0.158)	(0.144)	(0.213)
	Asian	0.053	0.075	0.042	0.047
		(0.254)	(0.267)	(0.202)	(0.213)
	Hispanic	0.008	0	0.021	0
		(0.150)	(0)	(0.144)	(0)
Smoke		0.008	0	0.021	0
		(0.087)	(0)	(0.144)	(0)
Vegetarian or vegan		0.061	0.1	0.063	0.023
		(0.240)	(0.304)	(0.245)	(0.152)
Alcohol		0.061	0.075	0.104	0
		(0.240)	(0.267)	(0.309)	(0)
Income level	Less than $40,000	0.435	0.450	0.395	0.465
		(0.498)	(0.503)	(0.494)	(0.505)
	$40,001–80,000	0.252	0.250	0.271	0.233
		(0.436)	(0.439)	(0.449)	(0.427)
	$80,001–120,000	0.069	0.100	0.021	0.093
		(0.254)	(0.304)	(0.144)	(0.294)
Education	Only high school	0.191	0.150	0.208	0.209
		(0.394)	(0.362)	(0.410)	(0.412)
	Undergraduate degree	0.282	0.30	0.271	0.279
		(0.452)	(0.494)	(0.449)	(0.454)
	Graduate degree	0.374	0.300	0.354	0.465
		(0.486)	(0.464)	(0.483)	(0.505)
# of subjects		131	40	48	43

Standard deviations are shown in parentheses below the mean values.

Table 2
Mean change in caloric consumption and expenditure by treatment.

	Treatment			
	All	Control	Inclusive tax	Exclusive tax
Change in caloric consumption	−66.557	−5.275	−109.896	−75.186
	(272.222)	(379.282)	(192.952)	(233.656)
Change in total expenditure	−0.001	−0.02	0.23	−0.24
	(1.668)	(1.390)	(1.991)	(1.501)
# of subjects	131	40	48	43

this category. However, given the data generated from the experiment, we do not have enough evidence to fully understand the role of taxes on snack food consumption.

Neither the inclusive tax nor the exclusive tax treatment had a significant impact on the intake of calories from fat, fiber, fat and sodium in any of the food categories. None of the nutritional factors changed significantly in any of the food categories in the exclusive tax treatment.

It is not surprising that the demand for the unhealthy items fell in both treatments, and it might be more appropriate to compare the two treatments directly (rather than to the control group). Therefore, we re-ran the DID model for the entire menu comparing the two treatments with each other without the control group. This helps us determine whether the impacts in the inclusive tax treatment and in the exclusive tax treatment are significantly different from each other. The change in total calorie consumption was not significantly different between the two treatments. However, empty calorie consumption in the inclusive tax treatment was reduced by significantly more compared to the exclusive tax treatment. Our results show that 52 fewer empty calories (49.9%)[5] were consumed in the inclusive tax treatment than in the

[5] The percentage change here is estimated by comparing the second menu selection of the exclusive tax treatment.

Table 3
Estimation results from DID model based on the entire menu; comparing each treatment with the control group.

	Calories	Empty calories	Calorie from fat	Carbohydrate	Fiber
Inclusive tax treatment	**−155.893*****	−12.055	**−29.031***	**−20.822*****	−0.144
	(57.846)	(21.203)	**(17.972)**	**(6.365)**	(0.524)
Exclusive tax treatment	−69.693	24.478	2.300	**−15.728****	**−1.078***
	(60.430)	(22.150)	(18.775)	**(6.649)**	**(0.548)**
Constant	**−681.872****	−53.336	−42.581	**−62.160****	1.690
	(262.474)	(96.207)	(81.550)	**(28.881)**	2.379
Dependent Variable Mean	−66.557	−4.557	−11.656	−2.284	0.276
	Fat	Cholesterol	Protein	Sugar	Sodium
Inclusive tax treatment	−5.528	**−25.445****	**−6.447****	**−12.831*****	**−249.167***
	(3.654)	**(11.292)**	**(3.217)**	**(4.891)**	**(147.853)**
Exclusive tax treatment	0.347	−1.573	−1.877	−6.047	66.687
	(3.818)	(11.797)	(3.361)	(5.110)	(154.458)
Constant	**−38.232****	−84.359	−23.924	−3.757	**−2559.575*****
	(16.582)	(51.239)	(14.593)	(22.193)	**(670.883)**
Dependent Variable Mean	−4.827	−13.878	−3.279	−0.544	−134.824
# of observations	131				
Socio-economic dummies	Gender, age, race, marital status, children, income level, educational level				
Other dummies	Alcohol and smoking habits, vegan or vegetarian, self-assessed weight status, preferences over organic food				

Standard errors in parentheses.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

Table 4
Main estimation results from DID model for three food categories; comparing each treatment with the control group.

	Beverage only			Entrée only			Snack only		
	Calories	Empty calories	Sugar	Calories	Empty calories	Sugar	Calories	Empty calories	Sugar
Inclusive tax treatment	**−28.771***	**−31.962***	**−9.222****	**−122.564***	−1.854	−1.757	−4.610	4.784	−1.100
	(16.424)	**(16.626)**	**(3.874)**	**(77.166)**	(18.629)	(1.114)	(30.400)	(6.970)	(2.745)
Exclusive tax treatment	−19.173	−17.144	−0.677	9.822	16.611	0.256	−23.207	0.263	−2.611
	(17.158)	(17.369)	(4.047)	(80.613)	(19.461)	(1.164)	(31.768)	(7.281)	(2.868)

Full estimation results are presented in Appendix A.6.
Standard errors in parentheses.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

exclusive tax treatment. The general guide for the daily limit on empty calories is 260 kcal for 19–30 year-old females and 330 kcal for 19–30 year-old males (USDA, http://www.choosemyplate.gov/weight-management-calories/calories/empty-calories.html). Fat and cholesterol intake changed significantly in the inclusive tax treatment, with fat content reduced by 6 g (26.2%) and cholesterol content reduced by 22 mg (36%). Researchers have concluded that a reduction in fat intake reduces the gap between total energy intake and total energy expenditure and thus would help reduce obesity (Bray and Popkin, 1998). Others have shown that greater body weight is linked to a higher rate of cholesterol synthesis (Miettinen, 1971). Hence, the significant reduction in the intake of empty calories, fat and cholesterol reinforces our conclusion that an inclusive tax has a significantly stronger impact than an exclusive tax on reducing the intake of undesirable nutritional factors.

To examine whether the results are different by major demographic factors, we re-ran the regression model with three interaction variables for gender, income, and race. However, none of the estimated coefficients on the interaction variables was statistically significant. This may be due, in part, to the limited size of our sample.

Discussion

We examined the impact of two types of taxes: an inclusive and an exclusive unhealthy food tax. Generally speaking, the inclusive tax had a stronger impact on the nutritional content of the meal. The inclusive tax, which the subjects experienced as a 20% unhealthy food excise tax, led to a reduction in the intake of total calories, calories from fat, carbohydrates, cholesterol, sugar and sodium. On the other hand, the 20% unhealthy food exclusive tax, only led to a significant reduction of carbohydrates. There are several potential explanations for this. First, unlike the tax inclusive treatment where the price increase on the unhealthy items is fully visible, subjects in the tax exclusive treatment may not know the tax status of the items since the menu prices (before checkout) remain the same. Although we did not ask subjects which items they thought were unhealthy, we subsequently sent out the exact same menu to the same subject pool we drew from and asked people if they agreed with our categorization of healthy and unhealthy items on the menu. Of the 42 responses, the majority (67%) agreed with our classification of unhealthy items, and those disagreeing pointed to just one item, diet soda, and disagreed that this is a healthy product. Based on this survey, we feel that most subjects in the experiment did know the tax status of the items on the menu.

A second explanation is that even for items that people are certain about the tax status, they may underestimate the after-tax price due to the complexity of calculating the amount of the tax. However, a recent study by Feldman and Ruffle (2015) found that subjects in their tax exclusive treatment were no different than those in their tax inclusive treatment along any observable measure, and they explicitly ruled out this explanation. A third possibility, and one that Feldman and Ruffle (2015) find, is that consumers are aware of the tax status, the tax rate, and understand how to compute it into the final price, but purposely ignore it. While our experiment cannot determine what causes subjects in the tax exclusive treatment to not respond as fully as those in the tax inclusive treatment, we find Feldman and Ruffle's (2015) conclusion as a plausible explanation for our results.

While both treatments had a negative impact on at least some undesirable nutritional factors, there were also unintended consequences of the taxes. Most notably, both tax treatments had negative impacts on the contents of some beneficial nutrients such as protein and fiber, and some of these impacts were statistically significant. One possible explanation is that for some subjects, the tax treatments nudged them into eating less, so instead of switching from an unhealthy item to a healthy one, they actually purchased fewer items in response to the tax. Additionally, the more uncertain subjects were about the tax, the fewer items they would purchase. Therefore, the consumption of beneficial nutrients such as fiber and protein decreased as the number of items ordered decreased.

If we investigate the impacts by food categories, the impact of the inclusive tax was still stronger than the exclusive tax in each category. This treatment had the strongest impact on beverage items, with more nutrients affected in this category than in any of the others, while the nutritional composition of the snack category was largely unaffected by either of the treatments. In addition, although both treatments had a positive effect on the fiber content in the entrée category, neither of these effects was significant – the effect of the taxes on beneficial nutrients was still perverse in all food categories.

By comparing the change in selected nutritional factors in the inclusive tax treatment with that in the exclusive tax treatment, we examined if the impacts of these two policies were significantly different. While the inclusive tax had a negative impact on most of the undesirable nutritional factors compared to the exclusive tax, the nutrients that changed significantly between the treatments were quite different from those between the treatments and the control group. The DID model comparing the two treatments yielded different results for factors such as empty calories and fat. The inclusive tax treatment had a significantly stronger impact in reducing empty calories, fat and cholesterol than the exclusive tax treatment. However, the change in calories was not significantly different between the treatments. A tax-inclusive price being more informative to the consumer could be one possible reason. As people were more familiar with calories than with most of the specific nutrients, subjects would avoid high-calorie items in both treatments, so the change in calorie content was not significantly different. Since the inclusive tax better informed people which item was indeed unhealthy, it helped in reducing the content of empty calories, cholesterol and other undesirable nutrients that people were less familiar with.

Conclusions

This research focused on the impact of two types of taxes on consumers' purchasing behavior. In order to identify the more effective policy for reducing obesity, we empirically examined the impact of an inclusive tax and an exclusive tax on consumption patterns by conducting a laboratory experiment. Based on our estimation results, both inclusive and exclusive tax had negative impacts on the consumption of undesirable nutritional factors such as cholesterol and sugar, but the inclusive tax was much more effective than the exclusive tax. This effect was robust to the entire menu, the beverage category and the entrée category. By comparing the change in nutrient content for the two treatments, the results indicate that the effect of the inclusive tax was significantly stronger than exclusive tax. However, both tax treatments had the unintended consequence of also reducing the consumption of the beneficial nutrients fiber and protein.

To obtain a better understanding of how the policies changed the nutritional composition by food category, we examined the change of nutrient content within each category. Here we found that in the inclusive tax treatment, compared to items selected in the other two categories, the change in the nutritional composition of selected beverages was the greatest.

Our study contributes to the existing literature by providing empirical evidence to support theoretical models of how the two types of taxes affect eating behavior. The key result of this study is that an inclusive tax policy has a significantly stronger effect than an exclusive tax in reducing the nutrient composition of the meal. This result is consistent with both Chetty et al. (2009) and Zheng et al. (2013) findings.

One important caveat of this study is it was conducted in a laboratory setting, and therefore the results should be viewed as an upper bound for the actual effect of various tax policies in the marketplace, it should serve as an indication of the relative effects of the proposed measures (Levitt and List, 2007). Also, consumers may learn over time and better adjust to the imposition of such a tax. Our experimental study is a single shot analysis of the imposition of the tax and we are not able to capture these potential long run effects. Further research is needed to study the long-term effects and examine the change in nutritional quality to such tax policies for a wider variety of food and beverage consumption settings. Despite the limitations of a lab experiment, our findings provide a comparison of the likely effects of inclusive taxes and exclusive taxes on caloric consumption and nutrient intake.

Appendix A

A.1. Items and respective prices in control and treatments

Category	Items	Price ($)	
		(1)	(2)
Beverage	*Diet Pepsi (20 oz.)	1.85	1.85
	Pepsi (20 oz.)	1.85	2.22
	*Gatorade Low Calorie	2.15	2.15
	Mountain Dew (20 oz.)	1.85	2.22
	*Unsweetened Iced Tea LIPTON	2.15	2.15
	Original Iced Tea LIPTON	2.15	2.58

(*continued on next page*)

Appendix A.1 (*continued*)

Category	Items	Price ($)	
		(1)	(2)
	Tropicana Lemonade	1.85	2.22
	*Propel Zero	2.25	2.25
	Grabba Whole Milk	1.49	1.79
	*Grabba Fat Free Milk	1.49	1.49
	Ocean Spray Juice Drink	2.15	2.58
	*Bottled Water	1.95	1.95
Entree	*Green Salad (Sesame or Balsamic Dressing)	7.49	7.49
	*Green Salad with Tuna (Sesame or Balsamic Dressing)	7.49	7.49
	3 Chicken Fingers	5.69	6.83
	Cheese Pizza (personal pan 6″)	4.25	5.10
	Pepperoni Pizza (personal pan 6″)	4.75	5.70
	Bacon Cheeseburger	6.27	7.07
	*Turkey Burger	4.49	4.49
	*Garden Burger	4.49	4.49
	French Fries	1.99	2.39
	*Tuna Salad Sandwich	4.99	4.99
	Chicken or Steak Fajita Quesadilla	6.79	8.15
	*Lo-Mien Noodle Bowl with Chicken	4.99	4.99
Snack	*Veggie Cup	2.99	2.99
	*Seaweed Salad	4.99	4.99
	*Tempura Vegetable Roll	6.49	6.49
	SunChips (small bag)	1.09	1.31
	*Fresh Apple	1.00	1.00
	*Fresh Banana	1.00	1.00
	*Fresh Orange	1.00	1.00
	5 Pack Cookies	1.89	2.27
	Brownie	1.59	1.99

(1) Posted and total price for items on menu A. Posted price for items on menu C.
(2) Posted and total price for items on menu B. Total price for items on menu C.
(3) Items with "*" were considered as healthy items that were exempt from taxes.

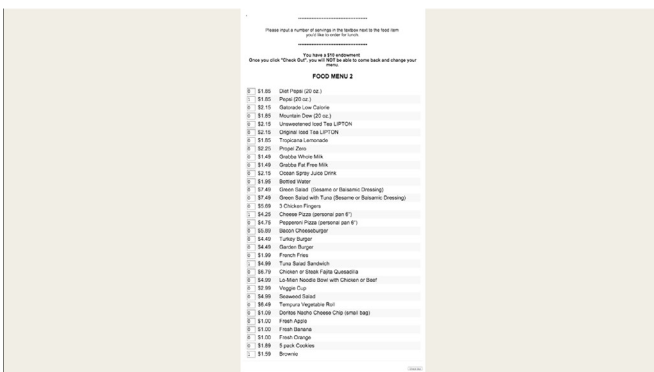
A.2. Nutrition Facts for the food and beverage items included in the menus

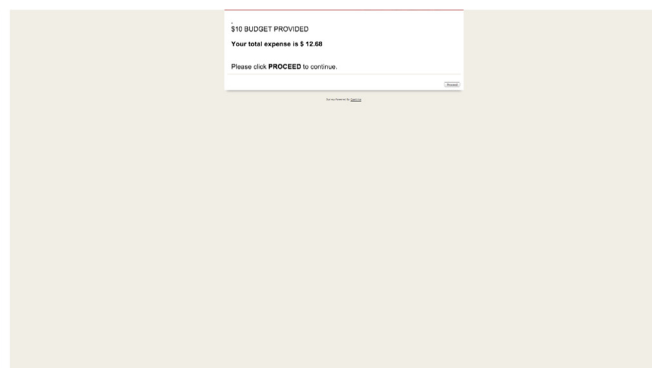
Nutrients	Calories (kcal)	Empty Calories (kcal)	Calories from fat (kcal)	Carbohydrate (g)	Fiber (g)	Fat (g)	Protein (g)	Cholesterol (mg)	Sugars (g)	Sodium (mg)
Diet Pepsi (20 oz.)	13	0	0	2	0	0	1	0	0	52
Pepsi (20 oz.)	250	231	0	65	0	0	0	0	69	27
Gatorade Low Calorie	52	0	0	12.64	0	0.07	0.33	0	3.08	293
Mountain Dew (20 oz.)	221	144	0	58	0	0	1	0	77	130
Unsweetened Iced Tea LIPTON	10	0	0	2	0	0	0	0	0	18
Original Iced Tea (LIPTON)	94	51	0	24	0	0	0	0	49	18
Tropicana Lemonade	279	305	0	70	0	0	0	0	63	48
Propel Zero	25	0	0	6	0	0	0	0	6.11	65
Grabba Whole Milk	260	150	150	20	0	14	14	42	21.56	184
Grabba Fat Free Milk	146	0	0	22	0	0	14	8	21.51	180
Ocean Spray Juice Drink	146	149	0	36	0	0	0	0	2.91	118
Bottled Water	0	0	0	0	0	0	0	0	0	10
Green Salad	139	90	29	13	2	9	2	0	3	492
Green Salad with Tuna	358	115	30	13	6	23	24	51	0	0
3 Chicken Fingers	731	8	8	37.89	1.8	45.7	42.03	104	0.52	1771
Cheese Pizza	284	91	78	31	2	13	11	15	12.44	474
Pepperoni Pizza	348	62	53	40	2	14	16	34	13.65	796
Bacon Cheeseburger	823	298	268	51	3	47	48	149	5	2078
Turkey Burger	186	27	27	0	0	10	22	81	6	343
Garden Burger	110	0	0	17.34	3.6	3.26	5.1	6	0.43	486
French Fries	271	24	24	32	3	14	3	0	0.33	164
Tuna Salad Sandwich	287	21	1	36	2	7	19	20	4	783

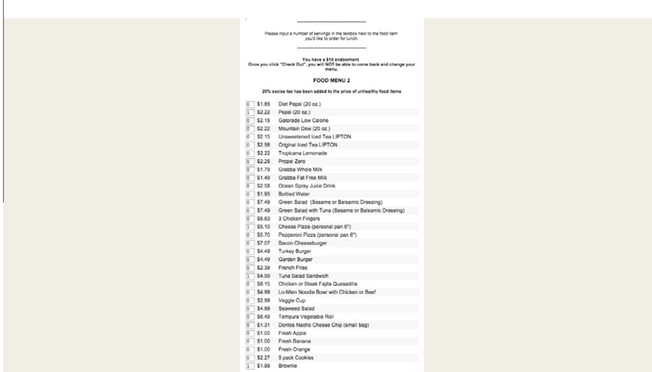
Appendix A.2 (*continued*)

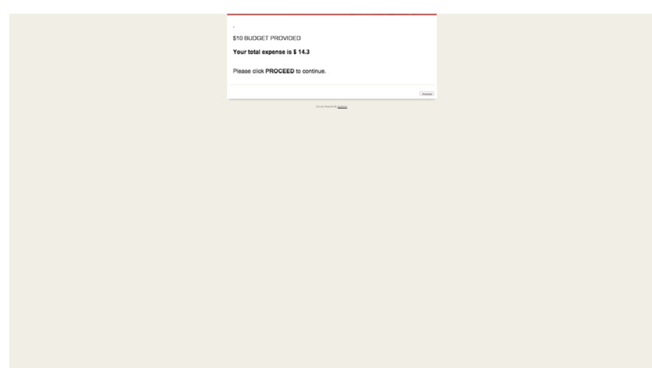
Nutrients	Calories (kcal)	Empty Calories (kcal)	Calories from fat (kcal)	Carbohydrate (g)	Fiber (g)	Fat (g)	Protein (g)	Cholesterol (mg)	Sugars (g)	Sodium (mg)
Chicken or Steak Fajita Quesadilla	596	69	69	37	2	35	32	98	7	1378
Lo-Mein Noodle Bowl with chicken	280	2	1	33	3	9	16	26	3.58	534
Veggie Cup	50	0	0	4	1	5	2	0	6	2
Seaweed Salad	63	0	0	4	1	5	2	0	2	9
Tempura Vegetable Roll	270	22	22	21	2	12	4	0	5	320
SunChips (small bag)	146	1	0	18	1	7	2	0	0.84	118
Fresh Apple	72	0	0	19	3	0	0	0	18.91	1
Fresh Banana	105	0	0	27	3	0	1	0	14.43	1
Fresh Orange	62	0	0	15	3	0	1	0	12.89	0
Cookies	380	51	17	52	1	17	4	45	28.48	334
Brownie	235	77	30	39	1	9	3	22	22.33	92

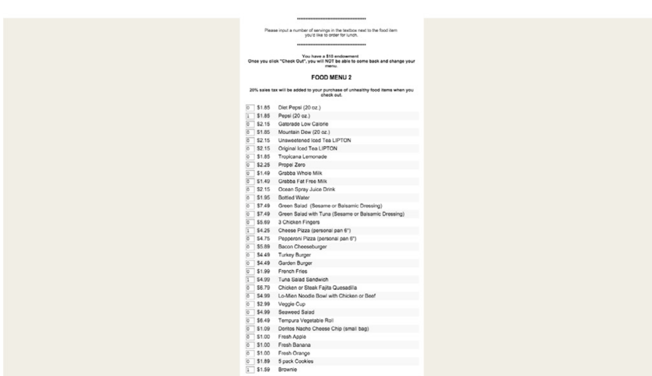
A.3. Screen shots of the 2nd menus for three groups











A.4. Socio-demographic questions and answer option list

#	Question	Answer options/description
1	What is your gender?	Drop-down list – Male – Female
2	What is your age?	Drop-down list – 20 or less – 21–30 – 31–40 – 41–50 – 51 or more
3	What is the highest level of education you have achieved?	Drop-down list – High School – Undergraduate degree – Associate degree – Graduate degree or higher
4	How would you describe yourself?	Drop-down list – Caucasian – African American – Asian/Asian American – Hispanic – Native American – Other
5	What is your family household income level?	Drop-down list – Less than $40,000 – $40,001–80,000 – $80,001–120,000 – $120,001–160,000 – Over 160,000 – Decline to answer
6	What is your marital status?	Drop-down list – Single – Married – Divorce
7	How many children do you have?	Drop-down list – No – One – Two – Three – Four – More than four
8	Do you smoke?	Drop-down list – Yes – No
9	Are you a vegetarian or a vegan?	Drop-down list – Yes – No
10	Do you drink alcoholic beverages?	Drop-down list – Yes – No
11	How would you describe your health condition?	Drop-down list – Underweight – Normal weight – Slightly overweight – Overweight – Obese

Appendix A.4 (*continued*)

#	Question	Answer options/description
12	Do you often buy organic products?	Drop-down list – Yes – No

A.5. Estimation results from DID model in logarithmic form based on the entire menu; comparing each treatment with the control group

$\Delta \log Y_i = \alpha_0 + \beta_1 D_1 + \beta_2 D_2 + \alpha_1 X_i + \varepsilon_i$

	Calories	Empty calories	Calorie from fat	Carbohydrate	Fiber
Inclusive tax treatment	**−0.209*****	−0.206	−0.379	**−0.249*****	−0.087
	(0.075)	(0.141)	(0.313)	**(0.057)**	(0.062)
Exclusive tax treatment	0.027	0.130	0.261	**−0.140****	**−0.128****
	(0.073)	(0.137)	(0.304)	**(0.056)**	**(0.060)**
	Fat	Cholesterol	Protein	Sugar	Sodium
Inclusive tax treatment	−0.157	**−0.324****	−0.087	**−0.494*****	**−1.038*****
	(0.128)	**(0.143)**	(0.089)	**(0.134)**	**(0.248)**
Exclusive tax treatment	**0.229***	**0.240**	0.129	−0.126	**−0.505****
	(0.125)	**(0.139)**	(0.086)	(0.130)	**(0.241)**
# of observations	131				
Socio-economic dummies	Gender, age, race, marital status, children, income level, educational level				
Other dummies	Alcohol and smoking habits, vegan or vegetarian, self-assessed weight status, preferences over organic food				

Standard errors in parentheses.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

A.6. Full estimation results from DID model for three food categories; comparing each treatment with the control group

	Beverage only				
	Calories	Empty calories	Calorie from fat	Carbohydrate	Fiber[a]
Inclusive tax treatment	**−28.771***	**−31.962***	0.818	**−7.827****	–
	(16.424)	**(16.626)**	(3.481)	**(3.834)**	
Exclusive tax Treatment	−19.173	−17.144	−3.957	−3.314	–
	(17.158)	(17.369)	(3.636)	(4.006)	
	Fat	Cholesterol	Protein	Sugar	Sodium
Inclusive tax treatment	0.076	0.360	0.255	**−9.222****	−2.741
	(0.374)	(1.031)	(0.728)	**(3.874)**	(9.914)
Exclusive tax treatment	−0.369	−1.196	−0.611	−0.677	−13.195
	(0.390)	(1.077)	(0.761)	(4.047)	(10.357)
	Entrée only				
	Calories	Empty calories	Calorie from fat	Carbohydrate	Fiber
Inclusive tax treatment	**−122.564***	−1.854	−22.484	−7.478	0.295
	(77.166)	(18.629)	(17.680)	(5.464)	(0.389)
Exclusive tax treatment	9.822	16.611	7.662	−0.792	0.073
	(80.613)	(19.461)	(18.469)	(5.708)	(0.407)
	Fat	Cholesterol	Protein	Sugar	Sodium
Inclusive tax treatment	−6.657	**−29.418****	**−7.280***	−1.757	−303.985
	(4.833)	**(14.598)**	**(4.221)**	(1.114)	(200.749)

(*continued on next page*)

Appendix A.6 (*continued*)

	Beverage only				
	Calories	Empty calories	Calorie from fat	Carbohydrate	Fiber[a]
Exclusive tax treatment	1.468 (5.048)	2.884 (15.250)	0.506 (4.410)	0.256 (1.164)	137.658 (209.716)
	Snack only				
	Calories	Empty calories	Calorie from fat	Carbohydrate	Fiber
Inclusive tax treatment	−4.610 (30.400)	4.784 (6.970)	1.627 (2.910)	1.138 (4.554)	−0.252 (0.390)
Exclusive tax treatment	−23.207 (31.768)	0.263 (7.281)	−0.300 (3.040)	−3.300 (4.757)	−0.584 (0.407)
	Fat	Cholesterol	Protein	Sugar	Sodium
Inclusive tax treatment	−0.648 (1.333)	2.765 (2.399)	−0.121 (0.388)	−1.100 (2.745)	−13.229 (24.740)
Exclusive tax treatment	−0.757 (1.392)	0.293 (2.506)	−0.245 (0.406)	−2.611 (2.868)	−17.400 (25.845)

Standard errors in parentheses.
[*] $p < 0.1$.
[**] $p < 0.05$.
[***] $p < 0.01$.
[a] Multicollinearity occurs when estimating the treatment effects on fiber, due to the low or zero fiber content of beverage items.

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