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Exploring how calorie information and taxes on high-calorie foods influence lunch decisions^{1–3}

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ABSTRACT

Background: The potential combined effects of public policy tools—such as calorie information and taxes on highly caloric foods—on purchasing behavior are rarely studied. Furthermore, these tools are rarely studied in the context of individual differences (eg, dietary restraint), which may play a key role in their effectiveness.

Objective: The current study tests the combined effects of providing calorie information and increased taxes on the total number of calories purchased for lunch. Furthermore, these public policy tools were investigated in the context of high- and low-restrained eaters.

Design: University students ($n = 178$) had to choose lunch from a menu 3 different times. The prices for the high-calorie foods on the menu increased each time (125% and 150% of base price). In addition, there were 3 between-subject factors: budget (high compared with low), calorie-information (calorie information compared with no calorie information), and dietary restraint.

Results: Elasticity analyses show a tax \times calorie information interaction. A price increase for the high-calorie foods reduced the percentage of calories chosen for lunch but only in the absence of calorie information.

Conclusions: A tax of $\geq 25\%$ on high-calorie foods may decrease the demand for calories and could be a good policy measure to decrease the prevalence of obesity. However, calorie information seems to interfere with the effect of a tax on high-calorie foods. *Am J Clin Nutr* 2011;93:689–94.

INTRODUCTION

The incidence of overweight and obesity is increasing worldwide. To curb the obesity epidemic, it is paramount that people attain a healthy, less-energy-dense diet (1). Public policy tools might be helpful in accomplishing this. Two such policy tools—calorie information and taxes on high-calorie foods—are the focus of this research.

According to behavioral economic theory, unhealthy choices can be altered to healthy choices by increasing the price of the unhealthy alternative (2). For example, this could entail making highly caloric foods more expensive. Increasing consumer financial costs associated with a product should eventually decrease demand for it. In a recent review, Andreyeva et al (3) estimated the elasticity of demand for food at 0.6, which means that a 1% price increase will decrease the demand for food by 0.6%. In another recent analysis, Fletcher et al (4) argued that taxing sugar-sweetened beverages would lead to a loss in body

weight. This effect of taxing on weight would, however, be small because people would likely consume fewer soft drinks but more calorie-dense beverages such as milk. Pricing strategies have also been examined in field studies in restaurants (5), schools (6, 7), and cafeterias (8, 9). These studies show that subsidizing healthy foods increases their consumption. Healthy food subsidies, however, do not seem to always lead to less consumption of not-so-healthy high-calorie foods. This corresponds with experimental research findings by Epstein et al (10). Participants in their experiment were instructed to buy items with a given budget. They could choose to buy different foods from a range of different items provided by the researchers. When the healthier foods from this set were made cheaper, the participants paradoxically bought more unhealthy foods. This was in contrast with what happens when the unhealthy foods were made more expensive. In that case, more expensive foods are purchased less, whereas less expensive foods are purchased more (11, 12). However, it is unclear from these experimental studies whether, in practice, the implementation of a tax on unhealthy fattening foods would entice people to switch from buying expensive high-calorie foods to purchasing less-expensive high-calorie alternatives, as suggested by the research by Fletcher et al mentioned above. If this is the case, imposing a tax on high-calorie foods would render revenues but not the desired overall decrease in calorie consumption.

Another suggestion made to change unhealthy eating behaviors is to provide a food's calorie information. Research has shown that consumers considerably underestimate the amount of calories for especially high-calorie products (13). Thus, providing calorie information might aid people in making healthier food choices. Empirically, however, results of providing calorie information have been weak and inconsistent (14). For example,

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² There was no funding source for this research.

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Received March 4, 2010. Accepted for publication January 3, 2011.

First published online January 26, 2011; doi: 10.3945/ajcn.110.008193.

Yamamoto et al (15) examined whether adolescents change their fast food orders if they receive information on calorie and fat content of their menu choices. They did not. In a field study, however, participants were offered to change their selected meal at a restaurant after receiving nutritional information on their initial meal choice. Here, more than half of the participants reduced the amount of energy of their second meal (16). In an experiment, it was found that nutrition information on menus decreased the choice for foods that were much less healthful than expected (13). In another experiment with college students though, only the female participants chose lower calorie meals and food items with calorie labeling. The male participants' menu selections were unaffected (17). Perhaps these inconsistent findings can be attributed to individual differences, such as restrained eating. Restrained eaters are concerned about their body weight and shape and thus attempt to restrict their caloric intake (18). Conceivably, the effect of providing calorie information may only be relevant to restrained eaters.

In the current study, the combined effects of a food tax and the provision of calorie information on total lunch calories purchased was examined to gain further insight into the relative efficacy of these 2 policy tools on purchasing behavior and how these tools may affect purchasing behavior within the context of dietary restraint. Each participant composed 3 lunches from 3 menus consisting of either high or low energy density and each energy-density category contained products of both expensive and cheaper products. The prices for the high-calorie products on the menu were increased each time participants composed their lunch. Because the perceived increase in the costs of purchasing a product does not just depend on its price but also on the magnitude of one's income, the amount of lunch money was varied between participants (\$10 compared with \$20). Furthermore, one group of participants was always informed of the number of calories contained by each of the products listed on the menu. We hypothesized that a food tax would reduce the amount of calories bought. Furthermore, we hypothesized that higher-restrained participants, in particular, would buy fewer calories when provided with calorie information.

SUBJECTS AND METHODS

Participants

This Institutional Review Board–approved study included 178 students (95 men) from a university in the northeast United

States. Students received extra credit in return for their participation. Participants were randomly assigned to the 4 different conditions: high budget/calorie information, high budget/no calorie information, low budget/calorie information, and low budget/no calorie information. Participant characteristics (age, hunger, Restraint Scale, and body mass index (in kg/m²) per group are displayed in **Table 1**.

Procedure and materials

In this study, the participants were tested between 1100 and 1330 within 3 d. Participants were tested in groups of <20 individuals; a single test session lasted ≈0.5 h. On arriving at the laboratory, each participant took a seat in front of a computer equipped with a private shield. Participants were instructed to read the information on the screen presented in front of them and they started the study after indicating their informed consent.

First, momentary hunger was measured on a 10-point scale (1 = “not at all hungry” to 10 = “very hungry”), which was followed by the selection of a hypothetical lunch from a menu 3 times. Participants were instructed not to exceed the amount of money with which they were provided (\$10 or \$20). In total, participants chose lunch 3 different times. The first time the prices on the menu were based on the prices of the university's school cafeteria. The second time, the prices for the high-calorie products were set at 125% of this price and the third time at 150% of the price. Participants were not informed about this, but were told that something on the menu had changed the second and third times the participants had to buy a lunch. This was done because we did not want to hint directly at the price changes, and we also wanted to avoid the possibility that participants would not take the task seriously and blindly choose the same set of products with each menu. Budget (\$10 or \$20) and calorie information (information or no information) varied between participants.

The menu consisted of 3 categories: main courses, desserts/snacks, and drinks. Each category contained 4 high-calorie products and 4 low-calorie products, which were 2 more luxurious products and 2 cheaper products. The items on the menu were the same for all participants. The high- and low-calorie items from the 3 different categories, together with their associated calorie contents and reference prices are shown in **Table 2**.

After buying lunch 3 times, the participants completed the Restraint Scale (18). This is a 10-item questionnaire concerning

TABLE 1
Subject characteristics¹

Variable	Low budget		High budget	
	With calorie information (n = 43)	Without calorie information (n = 43)	With calorie information (n = 50)	Without calorie information (n = 42)
Age (y)	19.9 ± 0.39	19.3 ± 0.40	20.0 ± 0.36	19.4 ± 0.40
Hunger rating (1–10) ²	4.7 ± 0.40	5.3 ± 0.41	4.8 ± 0.37	5.8 ± 0.41
Restraint Scale	14.3 ± 0.85	13.3 ± 0.86	13.9 ± 0.79	13.8 ± 0.86
BMI (kg/m ²)	24.0 ± 0.55	24.3 ± 0.56	23.4 ± 0.51	23.2 ± 0.56

¹ All values are means ± SEs.

² A significant main effect on hunger was found between the calorie information conditions, $F_{[1, 173]} = 4.53$, $P = 0.035$, $\eta_p^2 = 0.026$.

TABLE 2
Products on menu with calorie information and reference price

Product	Calories	Price
	<i>kJ</i>	<i>US\$</i>
Main courses		
High in calories		
More expensive		
Bacon cheeseburger	920	4.99
Steak fajita quesadilla	794	4.35
Less expensive		
Ham submarine sandwich (prepacked)	859	3.98
Peanut butter and jelly sandwich (prepacked)	716	2.79
Low in calories		
More expensive		
Deli vegetable sandwich	230	4.69
Classic Caesar salad with light Italian dressing	155	5.99
Less expensive		
Vegetable wrap (prepacked)	210	3.79
Vegetable salad (prepacked)	185	4.55
Desserts/snacks		
High in calories		
More expensive		
Brownie à la mode	300	2.25
Glazed donut	180	1.75
Less expensive		
Chips, barbecue	130	0.90
Chocolate candy bar	280	0.95
Low in calories		
More expensive		
Pineapple pieces	78	2.00
Strawberries	46	2.35
Less expensive		
Apple	55	1.00
Pear	75	1.00
Drinks		
High in calories		
More expensive		
Cola	250	1.39
Citrus soda	290	1.49
Less expensive		
Cola	250	1.19
Citrus soda	290	1.25
Low in calories		
More expensive		
Mineral water	0	1.49
Vegetable juice	70	1.85
Less expensive		
Water	0	1.29
Tomato juice	60	1.49

diet behavior and weight fluctuations. When finished on the computer, the participants were instructed to enter a separate room where height and weight were measured. Finally, the participants signed for their extra credit and were thanked for participating.

Design and analyses

Mixed-effects regression models were used to test for the elasticity of calories as a function of price. Elasticity of demand is the proportion change in consumption of a product relative to its proportion change in price. Elasticity of calories refers, in this case, to the percentage change in total calories bought relative to

the percentage change in price of the high-calorie products. Log values of the number of calories chosen and the log values of the average high-calorie product prices were used in the regression models.

To determine the price elasticity of calories, we tested the following regression model: $\ln \text{total calories} = \alpha + \beta_1 (\ln \text{average price of high-calorie products}) + \beta_2 (\text{restraint}) + \beta_3 (\text{budget}) + \beta_4 (\text{calorie information}) + \beta_5 (\text{hunger}) + \beta_6 (\ln \text{average price of high-calorie products} \times \text{restraint}) + \beta_7 (\ln \text{average price of high-calorie products} \times \text{budget}) + \beta_8 (\text{budget} \times \text{restraint}) + \beta_9 (\ln \text{average price of high-calorie products} \times \text{calorie information}) + \beta_{10} (\text{calorie information} \times \text{restraint}) + \beta_{11} (\text{calorie information} \times \text{budget}) + \beta_{12} (\ln \text{average price of high-calorie products} \times \text{budget} \times \text{restraint}) + \beta_{13} (\ln \text{average price of high-calorie products} \times \text{calorie information} \times \text{restraint}) + \beta_{14} (\ln \text{average price of high-calorie products} \times \text{budget} \times \text{calorie information}) + \beta_{15} (\text{restraint} \times \text{budget} \times \text{calorie information}) + \beta_{16} (\ln \text{average price of high-calorie products} \times \text{restraint} \times \text{budget} \times \text{calorie information})$, with random intercept and hunger as covariates and budget and calorie information as categorical variables. β_1 represents the demand elasticity; when this estimate is negative, it means that the demand for calories decreases with increasing prices for high-calorie products. These analyses were performed with SYSTAT (version 13; Systat Software Inc, Chicago, IL).

Because the mixed-regression model only allows for the examination of relative differences in calorie purchase/demand, the data were also analyzed in a 3 (tax: 100% price, 125% price, and 150% price) \times 2 (calorie information: with compared with without) \times 2 (budget: high compared with low) \times 2 (restraint: high compared with low) split plot analysis of covariance (ANCOVA), with hunger as a covariate, tax as a within-subjects factor, and calorie information, budget, and restraint (median split on 14.5) as between-subjects factors. Hunger was entered as a covariate because the calorie information conditions significantly differed on initial hunger, $F_{[1, 173]} = 4.53, P = 0.035, \eta_p^2 = 0.026$. Huynh-Feldt epsilon corrections were applied to control for the violation of the assumption of sphericity for all repeated-measures analyses (19). Accordingly, the adjusted df values are reported. Partial eta squared (η_p^2) is reported as a measure of effect size. These analyses were performed with SPSS (version 18; SPSS Inc, Chicago, IL).

RESULTS

Price elasticity of calories

As can be seen in **Table 3**, the regression analysis showed a significant main effect for restraint (estimate = $-0.057, P = 0.0015$), which indicated that the demand for calories decreased with an increase in restraint score. Hunger is a significant covariate (estimate = $0.053, P = 0.002$), which means that the demand for calories increased with the level of hunger. Furthermore, the analysis showed a significant main effect for tax (estimate = $-0.435, P < 0.001$) and calorie information (estimate = $-0.345, P = 0.007$). These latter 2 main effects are qualified by a significant interaction of tax by calorie information (estimate = $0.345, P = 0.003$). To further explore this interaction, a separate regression analysis was performed per level of the condition "calorie information." The regression

TABLE 3Results of mixed-regression analysis, with estimates, SEs, and *P* values¹

Variable	Estimate	SE	<i>P</i>
Intercept	6.842	0.13	<0.001
Tax	-0.435	0.12	<0.001
Restraint	-0.057	0.02	0.015
Budget	0.174	0.13	0.171
Calorie information	-0.345	0.13	0.007
Hunger	0.053	0.02	0.002
Tax × restraint	0.034	0.02	0.106
Tax × budget	-0.045	0.12	0.698
Budget × restraint	0.004	0.02	0.875
Tax × calorie information	0.345	0.12	0.003
Calorie information × restraint	-0.026	0.02	0.267
Budget × calorie information	0.084	0.13	0.509
Tax × budget × restraint	0.005	0.02	0.801
Tax × calorie information × restraint	0.032	0.02	0.138
Tax × budget × calorie information	-0.043	0.12	0.711
Budget × calorie information × restraint	0.010	0.02	0.678
Tax × budget × calorie information × restraint	0.006	0.02	0.761

¹ Note that repeating the same mixed-regression analysis without the nonsignificant 4- and 3-factor interactions as presented in this table showed the same pattern of results.

analysis for the “no calorie information” condition showed a significant main effect for tax (estimate = -0.780, *P* < 0.001), which indicated that a price increase for high-calorie food products was associated with a decrease in calorie purchases. The analysis for the “calorie information” condition did not show such an effect for tax (estimate = -0.087, *P* = 0.596). A price increase for high-calorie products did not lead to a decrease in calorie purchases.

ANCOVA

The 3 (tax: 100% price, 125% price, and 150% price) × 2 (calorie information: with compared with without) × 2 (budget: high compared with low) × 2 (restraint: high compared with low) × (hunger) ANCOVA yielded a main effect for tax: $F_{[2, 338]} = 13.55$, *P* < 0.001, $\eta_p^2 = 0.047$. This main effect was qualified by a significant interaction effect of tax × calorie information × restraint ($F_{[2, 338]} = 4.08$, *P* = 0.018, $\eta_p^2 = 0.024$), which indicated that, ceteris paribus, a price increase lowered the number of calories bought by low-restrained participants irrespective of calorie information, whereas a tax only reduced the number of calories bought without calorie information by high-restrained participants. Furthermore, there was a main effect for budget, which showed that the participants who had a high spending budget bought more calories than did participants with a low budget: $F_{[1, 169]} = 7.53$, *P* = 0.007, $\eta_p^2 = 0.043$. Budget, however, did not significantly interact with any of the other factors (smallest *P* = 0.208). The covariate hunger was also significant ($F_{[1, 169]} = 6.42$, *P* = 0.012, $\eta_p^2 = 0.037$), but also did not significantly interact with any of the other factors (smallest *P* = 0.137). In other words, the hungrier the participants were the more calories they bought. The mean numbers of calories bought per price change, with or without calorie information for the high-restrained and low-restrained participants separately, are shown in **Figure 1**.

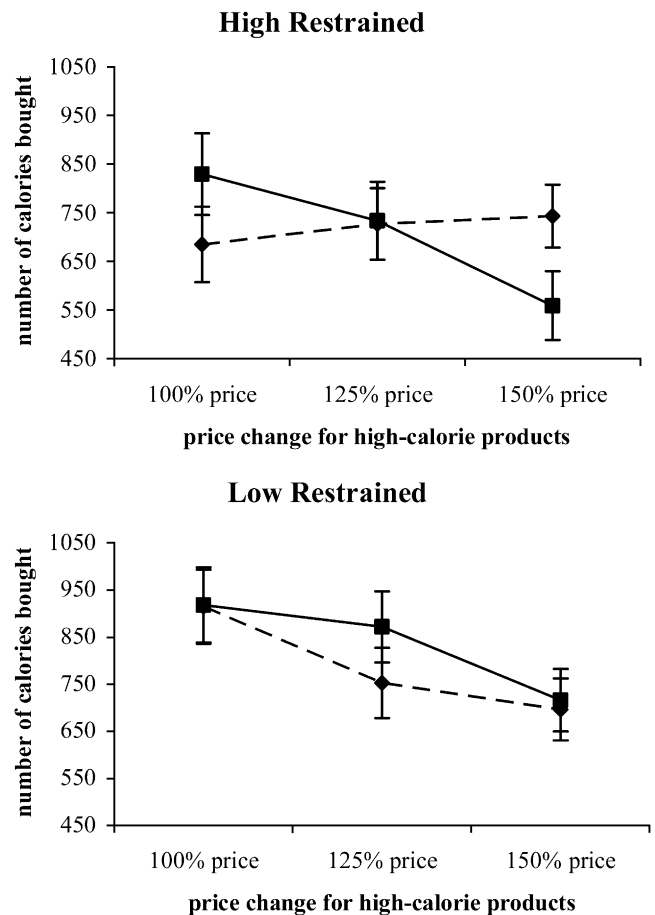


FIGURE 1. Number of calories bought per price change, with (◆) or without (■) calorie information, for the high-restrained participants (top panel: with calorie information, *n* = 48; without calorie information, *n* = 41) and the low-restrained participants (lower panel: with calorie information, *n* = 45; without calorie information, *n* = 44) collapsed across the factor “budget” (low compared with high). ANCOVA showed a significant interaction of tax × calorie information × restrained (*P* = 0.004). Low-restrained participants bought fewer calories with a price increase, regardless of whether they received calorie information (*P* < 0.001). For high-restrained participants, a significant interaction of tax × calorie information was found (*P* = 0.010), and they reduced the number of calories with an increase in price only when they received no calorie information.

To further investigate the 3-factor interaction of tax × calorie information × restraint, post hoc tests per group of restraint on tax × calorie information were performed, which showed that in the low-restrained group only tax had a significant main effect: $F_{[2, 172]} = 11.93$, *P* < 0.001, $\eta_p^2 = 0.122$. In the high-restrained group, the main effect for tax was not significant, $F_{[1.81, 155.25]} = 2.97$, *P* = 0.059, $\eta_p^2 = 0.033$. However, a significant interaction effect of tax × calorie information was observed ($F_{[1.81, 155.25]} = 4.96$, *P* = 0.010, $\eta_p^2 = 0.055$), which meant that tax was only effective without calorie information (Figure 1).

To obtain further insight in the spending pattern of participants, we looked at what percentage of the participants spent >90% of their budget in the 3 consecutive sessions: 14%, 22.2%, and 23.2%, respectively. This too indicates that, with increasing prices, people will spend more money on food. At the same time, these proportions show that most participants could still afford to buy high-calorie foods but (as the results above indicate) chose not to do so with increasing prices.

DISCUSSION

In the present study we investigated the effect of a tax on high-calorie products and of the provision of calorie information on the amount of calories bought for lunch. As hypothesized, a food tax reduced the amount of calories people bought, but this effect was limited to the participants not having received any calorie information. It appears that, with calorie information, the participants attended only to this information and not necessarily to the costs associated with their meal selections. However, to conclude that the introduction of a food tax is redundant when one already provides calorie information at point of purchase would be premature.

As noted above, the mixed-regression analysis only allowed for the examination of relative changes in calorie purchase. From the standpoint of the economist, this is important because this analysis allows one to determine demand elasticity, but from the viewpoint of a health professional or even policy maker one would rather want to know the degree to which any of the examined measures lowers absolute consumption. Indeed, if with some policy measure person A purchased 10 kcal less and person B bought 100 kcal less for lunch for the rest of their respective lives, the health effect of the measure would obviously be much greater for person B than for person A. Still, a relative change in consumption might be exactly the same for both persons A and B. By using an ANCOVA, we assessed absolute changes in consumption and found the same tax \times calorie information interaction as with the mixed-regression model, but with the ANCOVA this interaction was moderated by restraint status. Only the high-restrained eaters who received calorie information did not respond in an economic way to the food tax (Figure 1). This might be explained by the fact that high-restrained eaters try to limit their calorie intake and are able to adjust the energy content of their lunch to a certain caloric boundary because they receive information on the caloric content of the products they eat. On the basis of this line of reasoning, this scenario may no longer be relevant when a tax is introduced because they have already adjusted to their caloric boundary and will continue to buy the products as long as they can afford them.

For both types of analysis, the effect of a food tax occurred irrespective of the amount of money the participants could spend on buying lunch. Nevertheless, budget did matter in that the participants who had \$20 to spend bought more calories overall than did the participants who only had \$10 to spend. Because the menu in this study offered both expensive and less expensive high-calorie products as a choice for lunch, the results also suggest that people will not substitute the purchase of expensive high-calorie foods for high-calorie cheaper products.

As for the limitations of the present study, one might argue that the effect of the tax cannot be separated from the effect of the participant seeing the same menu for the second or third time because the 3 price conditions were not randomized. This is true; however, in reality, an imposed tax entails a price increase that people evaluate in light of the price of the commodity before taxation. Therefore, if we had randomized the order of the price conditions, participants might have viewed a price change in a substantial number of instances as the introduction of a discount (ie, a considerable price reduction relative to its previous price), specifically with the high-calorie menu items. Because we were interested in the effects of a perceived price increase rather than

a price reduction, we deemed it important not to counterbalance or randomize the order of the price conditions. It also must be noted that we only tested university students, which means that we could not be certain that the present pattern of results also applies to the general population. Furthermore, the choices for lunch were hypothetical. Note, however, that the participants were led to believe that there was a real chance that they might receive one of their chosen lunches, which was done to ensure that the participants would take the task seriously. Nonetheless, the budget for composing the lunches was also hypothetical, which meant that there were no profits from saving money for the participants and that for this particular reason they might have chosen to buy more food items than they normally would do. If so, one would expect that most, if not all, of the participants spent the whole of their budget when composing a lunch from the menu. However, only 14% of the participants spent $>90\%$ of their budget.

In sum, a food tax of $\geq 25\%$ makes nearly everyone buy fewer calories. Calorie information on the other hand seems to interfere with taxing (especially for those who already have the intention to eat fewer calories) (20). Further research is necessary to be able to evaluate whether smaller taxes are just as effective. If so, it should be tested whether this is also the case with a more general and representative sample. It is interesting that, especially for restrained eaters, calorie information combined with a food tax does not seem to add to a more healthy food choice. However, this interaction of calorie information and tax too needs further research, not speculation.

The authors' responsibilities were as follows—JCAHG, RCH, and CRP: designed the study; JCAHG and CRP: organized and performed the study; JCAHG: analyzed the data and wrote the first draft of the manuscript; and RCH, AJ, and CRP: provided critical input and feedback on the manuscript. All authors approved the final version of the manuscript. None of the authors had a personal or financial conflict of interest.

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