Do high vs. low purchasers respond differently to a nonessential energy-dense food tax? Two-year evaluation of Mexico's 8% nonessential food tax

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ABSTRACT

It is unclear whether response to a nonessential food tax varies across time or for high vs. low-consuming households. The objective is to examine whether the effect of Mexico's 2014 8% nonessential energy-dense foods tax increased in the second year post-implementation and whether it differentially affected households by pre-tax purchasing pattern. We used longitudinal data on Mexican household food purchases ($n = 6089$ households) from 2012 to 2015. Households were classified based on median pre-tax purchases: low untaxed/low taxed ("low"), low untaxed/high taxed ("unhealthy"), high untaxed/low taxed ("healthy"), and high untaxed/high taxed ("high") purchasers. Fixed effects models tested whether observed post-tax purchases differed from the counterfactual, or what would have been expected based on pre-tax trends. Post-tax declines in the % taxed food purchases increased from −4.8% in year one to −7.4% in year two, yielding a 2-year mean decline of 6.0% beyond the counterfactual ($p < 0.01$). Post-tax change in % taxed food purchases varied by pre-tax purchasing level. Healthy purchasers showed no post-tax change in % taxed food purchases beyond the counterfactual, while unhealthy, low and high purchasers decreased (−12.3%, −5.3% and −4.4%, respectively) ($p < 0.01$). The positive effect of Mexico's junk food tax continued in the second year, and households with greater preferences for taxed foods showed a larger decline in taxed food purchases.

1. Introduction

With one of the highest levels of child and adult overweight and obesity, (Barquera et al., 2013; Rivera et al., 2014), very high intakes of a diet high in energy-dense, ultra-processed food and drinks including sugar-sweetened beverages (SSBs) and nonessential food (often termed 'junk food') (Barquera et al., 2010; Barquera et al., 2008; Hawkes, 2006; Pan American Health Organization, 2015; Stern et al., 2014) and high diabetes levels, the Mexican government implemented a 1 peso per liter tax on SSBs (equivalent to approximately 10% tax), and an 8% tax on nonessential foods with energy density ≥ 275 kcal/100 g, with the latter representing 14% to 21% of daily caloric across age groups (Aburto et al., 2016). The gross revenue specifically collected for the nonessential food tax in 2014 and 2015 was 29.6 billion MXN pesos (~2 billion USD) (Secretaría de Hacienda y Crédito Público, 2015).

Evaluations of the impact of the SSB tax and non-essential foods tax found that it was linked, on average, to a 6% and 5% decline in purchases of taxed beverages and food, respectively (Batis et al., 2016; Colchero et al., 2016), with low-income households reducing purchases more. However, these evaluations focus only on mean changes across the population, regardless of pre-tax purchasing behaviors. Yet, households who consumed high levels of junk food prior to the tax may show greater response to the tax, since the tax will disproportionately affect their food budgets. On the other hand, high junk food consumers may respond less to a tax, if strong junk food preferences reduce sensitivity to price changes (Etilé and Sharma, 2015).

In addition, households do not purchase taxed foods in isolation; rather, these goods are purchased alongside untaxed items. Taxes can also affect via substitution effects untaxed products.

The objective is to examine whether Mexico's 8% nonessential energy-dense foods tax differentially affected households with varying pre-tax purchasing levels in the two years post-implementation.

2. Methods

We used secondary, de-identified data, exempted from approval by the UNC and INSP Institutional Review Boards.

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[1] The authors have no conflict of interest to report.

2.1. Sample

Longitudinal data on household food purchases from January 2012 to December 2015 from The Nielsen Company's Mexico Consumer Panel Services (CPS). Enumerators visit participating households every two weeks to register purchases of mainly packaged barcoded products (diaries of purchases, receipts, inventory of the pantry, and designated bin with empty product packages).

Nielsen CPS samples households from 53 cities and is representative of the Mexican urban population (>50,000 inhabitants). We included all households participating for at least two months from January 2012–December 2015, and excluded 556 because they did not have data in 2012–2013. The final analytical sample includes 262,367 household-months, across 6089 unique households. Average household follow-up was 43.1 months, with 70.6% participating in all 48 months.

2.2. Food categories

For a product to be taxed it has to comply with two conditions: be defined as "non-essential food" by the law and have ≥275 kcal/100 g. A team of Mexican registered dieticians reviewed each product and assigned it into a tax category based on this criteria. Examples of taxed and untaxed items included can be found in Supplemental Table 1. We did not include products that were not purchased by the household (i.e., gifts), and food categories that were not collected during the 48 months such as chocolates, candies, bread from bakery, tortillas and other unpackaged produce.

2.3. Covariates

Household socio-economic status (SES) was categorized using Nielsen's scoring system, which classifies households into 7 categories. We classified SES as low (lower two categories), medium (mid-three categories) and high (higher two categories). We also included household composition (member's age and sex) and head of household education level. Contextual measures included state-quarter unemployment rates (Instituto Nacional de Estadística y Geografía and empleo, 2014) and minimum salary (Comisión Nacional de los Salarios Mínimos, 2015) adjusted by state-quarter consumer price index.

2.4. Statistical analysis

All analyses were conducted in Stata version 14.2 (College Station, TX).

To examine whether the tax differentially impacted groups based on their pre-tax purchasing patterns, we calculated, for each household, the mean volume of taxed and untaxed food purchases during 2012–2013 and categorized them as high [above or equal to the median (378 g/capita/month for taxed foods and 1157 g/capita/month for untaxed foods)] and low (below the median). We then combined taxed and untaxed categories into four groups:" low" (low taxed – low untaxed; $n = 2209$)," healthy" (Low taxed – high untaxed; $n = 835$)," unhealthy" (high taxed – low untaxed; $n = 835$), and "high" (high taxed – high untaxed; $n = 2210$).

We first describe socio-demographic characteristics for the overall sample and each group over time. To evaluate the tax, we used the approach previously described (Colchero et al., 2016) (Batis et al., 2016) to conduct a pre-post comparison while accounting for the ongoing 2012–2013 trend (and to avoid assuming a decrease in purchases in 2014 was attributable to the tax if there was already a downward trend).

The fixed-effects model specification was as following:

$$Food_{hmy} = \alpha + \beta_{T-14}T{-}14_{my} + \beta_{T-15}T{-}15_{my} + \beta_S S_{my} + \beta_{T-14S}(T{-}14_{my} * S_{my}) + \beta_{T-15S}(T{-}15_{my} * S_{my}) + \beta_y Y_y + \Upsilon{\cdot}H_{hy} + \phi{\cdot}C_{my} + \lambda_h + \mu_{hmy}$$

Food was the volume of taxed (g/capita/month), volume of untaxed (g/capita/month) or % taxed foods purchases in household *h*, month *m* and year *y*. *T-14* is the 2014 post-tax period (0 = 2012, 2013, 2015; 1 = 2014), *T-15* is the 2015 post-tax period (0 = 2012, 2013, 2014; 1 = 2015), *S* is 2nd semester (0 = Jan–Jun; 1 = Jul–Dec), *Y* is year (a continuous measure 0 = 2012; 1 = 2013; 2 = 2014; 3 = 2015), *H* denotes the vector of year-specific household characteristics (SES, and household composition), C denotes the vector of contextual measures (unemployment rates and minimum salary), λ and μ are the error terms. We included a semester effect, to assess changes within the year. The year slope reflects the 2012–2013 change only and not the 2012–2015 change, because even if *Y* is a continuous variable that included all years, the model is adjusting by 2014 and 2015 (*T-14* and *T-15*). Hence the only slope available for model estimation within these 2012–2013, 2014 and 2015 periods is 2012–2013. However, having *Y* as a continuous variable with all years included allows *T-14* to be interpreted as the difference in *Food* during 2014 compared to the pre-tax period (on the Jan-Jun semesters), beyond the change that was expected if the *Y* trend of 2012–2013 continued linearly through 2014.

Based on this model, we predicted the mean adjusted volume or % taxed purchased in each month pre-tax, post-tax counterfactual (the continuation of the 2012–2013 trend trough 2014 and 2015), and post-tax observed, to estimate the absolute and relative differences between observed and counterfactual. In the case of models for volume of purchases, we estimated the per capita volume dividing the total household purchases by the number of household members, regardless of the age/sex of these. Therefore, we included household composition as covariates in the model.

We focus on estimates of % taxed, as this estimate represents the change in taxed food purchases relative to total food purchases. This is important because a decline in taxed food purchases when considered in isolation could simply reflect an overarching decline in total (taxed and untaxed) food purchases rather than a tax effect, whereas a decline in the % taxed represents a shift away from taxed food towards untaxed food. In exploratory analyses, we did find that both taxed and untaxed food purchases declined in 2015.

In all analyses, we used the household weights provided by Nielsen (households are weighted based on household composition, locality, and SES to match demographic estimates from the National Institute of Statistics and Geography). We estimated standard errors via bootstrapping by drawing 1000 random samples with replacement with selection at the household level.

3. Results

Socio-demographic characteristics of the total sample and each purchasing group are found in Table 1. Overall, the total volume of food purchases declined from 1798 to 1607 g/capita/month. Households in the Low and Unhealthy purchasing group tended to be disproportionately low SES relative to the other groups, while households in the High group were disproportionately likely to have a university degree or higher, and households in both the High and the Healthy group where more likely to be High-SES. Households in the Low group and the Unhealthy Group were less likely to have children <18 y. High purchasing household purchased the greatest volume of total food purchases in 2015 (2357 g/capita/month), followed by Healthy-purchasing households (1569).

Unadjusted mean volume of taxed and untaxed food purchases can be found in Fig. 1. Adjusted results comparing the post-tax observed to the post-tax counterfactual for volume of taxed and untaxed foods can be found in Table 2, Supplemental Table 2, and Supplemental Figs. 1 and 2. In the overall sample, the absolute volume of taxed purchases declined from 436 to 418 g/capita/month (−4.0%) in 2014 and from 414 to 355 g/capita/month (−14.2%) in 2015; whereas untaxed purchases increased from 1257 to 1292 g/capita/month (+2.8%) in 2014 and decreased from 1195 to 1137 g/capita/month (−4.9%) in 2015. Because in 2015 the volume of both taxed and untaxed purchases decreased, we focused instead in the change in the percentage of taxed purchases, as this estimate

Table 1
Socio-demographic characteristics associated with trajectory groups.

	Total households		Low (low taxed/low untaxed)		Healthy (low taxed/high untaxed)		Unhealthy (high taxed/low untaxed)		High (high taxed/high untaxed)	
	2012 ($n = 5813$)	2015 ($n = 4963$)	2012 ($n = 2101$)	2015 ($n = 1741$)	2012 ($n = 805$)	2015 ($n = 694$)	2012 ($n = 784$)	2015 ($n = 682$)	2012 ($n = 2123$)	2015 ($n = 1846$)
Total food purchases (g/capita/month) (mean ± SE)	1798 ± 26	1607 ± 31	909 ± 19	854 ± 25	1985 ± 55	1569 ± 66	1485 ± 41	1346 ± 52	2731 ± 48	2357 ± 53
Untaxed food purchases (g/capita/month) (mean ± SE)	1342 ± 21	1210 ± 25	703 ± 16	663 ± 21	1712 ± 51	1351 ± 60	914 ± 31	912 ± 40	2002 ± 39	1732 ± 45
Taxed food purchases (g/capita/month) (mean ± SE)	455 ± 8	397 ± 10	206 ± 6	191 ± 8	273 ± 11	218 ± 14	571 ± 20	433 ± 24	728 ± 16	625 ± 20
% taxed foods (mean ± SE)	26 ± 0.32	25 ± 0.46	23 ± 0.56	23 ± 0.81	15 ± 0.58	14 ± 0.85	39 ± 0.94	33 ± 1.23	27 ± 0.45	28 ± 0.7
Head of household education (%)										
No education	17	15	25	24	15	16	18	15	10	8
Primary	22	23	27	28	22	22	24	24	17	19
Secondary	27	29	25	28	26	24	31	30	27	31
High-school	22	25	17	16	24	30	19	23	26	32
University or higher	13	8	7	4	12	7	9	7	20	11
Socio-economic status (%)										
Low	21	23	26	32	16	17	25	28	14	16
Middle	58	52	61	53	56	51	59	53	56	51
High	22	25	13	15	29	32	15	19	30	33
Household composition										
With children ≤18y, %	18	24	11	14	33	40	9	13	22	30
Age of children in households with children (mean ± SE)	9 ± 0.1	10 ± 0.13	8 ± 0.16	9 ± 0.2	10 ± 0.34	10 ± 0.45	8 ± 0.23	10 ± 0.25	9 ± 0.18	11 ± 0.22
Without children ≤18y, %	82	76	89	86	67	69	91	87	78	70
Age of adults >18y in households without children (mean ± SE)	45 ± 1.89	45 ± 0.85	46 ± 1.24	44 ± 1.16	45 ± 1.79	46 ± 0.87	46 ± 1.13	45 ± 1.89	45 ± 0.85	46 ± 1.24
Region										
Central north	20	20	23	25	21	18	22	20	16	17
Central south	14	14	16	16	12	13	16	15	13	12
Mexico city	27	28	28	27	24	25	28	28	27	30
Northeast	19	19	19	19	20	19	19	21	19	19
Northwest	10	10	4	5	13	11	5	5	17	15
South	9	9	10	8	10	14	10	11	8	8

Source: Authors' own analyses and calculations based in part on data reported by Nielsen through its Mexico Consumer Panel Service for food and beverages or the January 2012 to December 2015. Nielsen data is licensed from The Nielsen Company, 2017. The conclusions drawn from the Nielsen data are those of the authors and do not reflect the views of Nielsen. Nielsen is not responsible for and was not involved in analyzing and preparing the results reported herein. Weights provided by Nielsen to represent populations in areas with >50,000 inhabitants. Values may not sum to 100% due to rounding.
Note: analysis is on unique households.

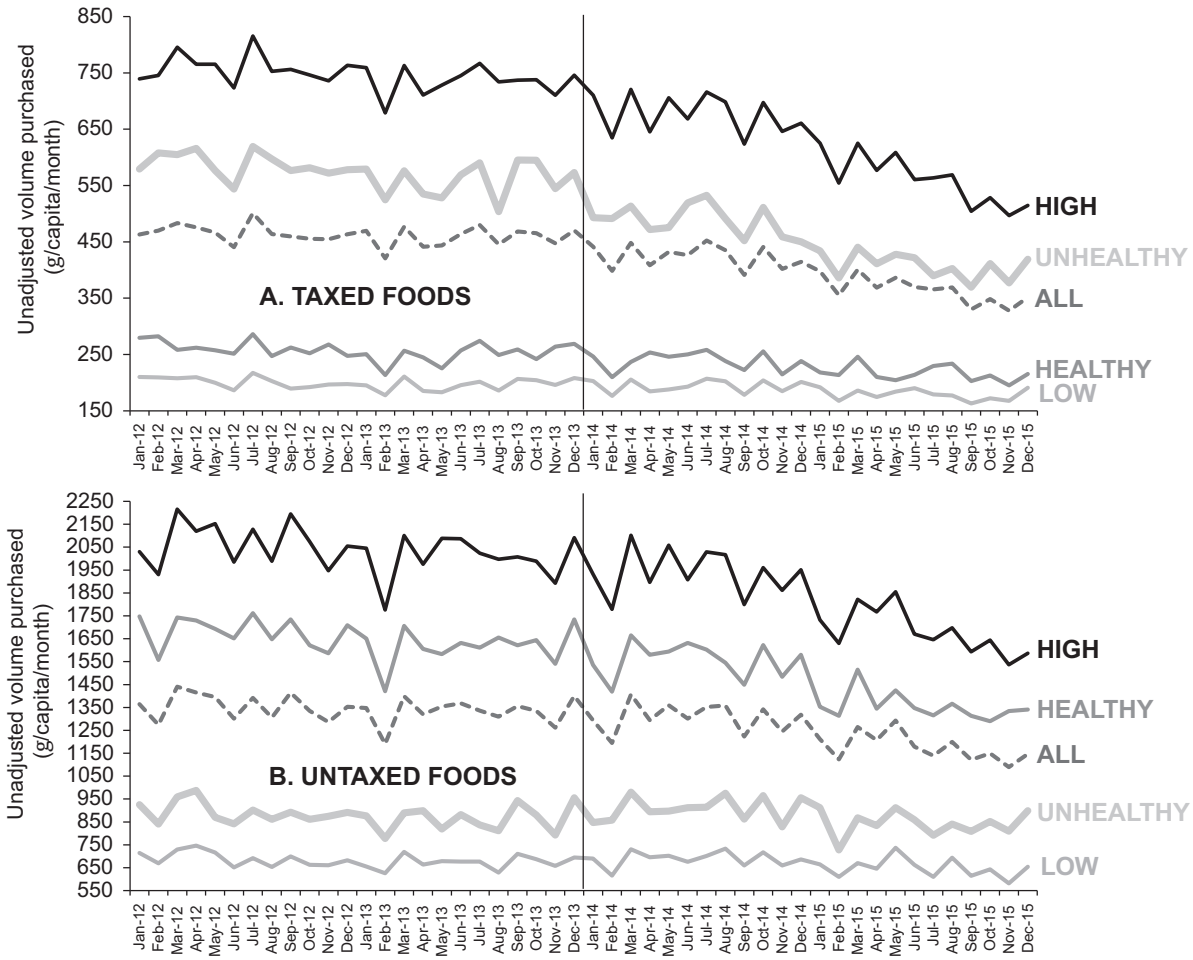

Fig. 1. Unadjusted monthly trends in predicted volume purchased (g/capita/month) of A) Taxed and B) Untaxed foods for the overall sample and by pre-tax household food purchasing group. Source: Authors' own analyses and calculations based in part on data reported by Nielsen through its Mexico Consumer Panel Service for food and beverages or the January 2012 to December 2015. Nielsen data is licensed from The Nielsen Company, 2017. The conclusions drawn from the Nielsen data are those of the authors and do not reflect the views of Nielsen. Nielsen is not responsible for and was not involved in analyzing and preparing the results reported herein.

represents the relative difference in purchases of taxed purchases relative to total food purchases. In 2014 the % taxed decreased from 26.4 to 25.1 or by 1.3 percentage points (pp) (−4.8% difference); in 2015 it decreased from 26.5 to 24.5% or −2.0 pp. (−7.4% difference); and in 2014 and 2015 together it decreased −1.6 pp. (−6.0% difference).

By household groups, in 2014 and 2015, there were no differences in the observed post-tax % taxed food purchases compared to the counterfactual post-tax purchases for Healthy-purchasing households (14.3 vs 14.3%taxed). The Low group decreased from 24.5 to 23.2% taxed or −1.3 pp. (−5.3% difference); the High group decreased from 27.5 to 26.3% taxed or −1.2 pp. (−4.4% difference) and the Unhealthy group decreased the most, from 39.8 to 34.9% taxed or −4.9 pp. (−12.3% difference).

As shown in Fig. 2, the % taxed was slightly higher during the second semester compared to the first semester. Moreover the pre-tax trend is zero for % taxed whereas for the volume of taxed and untaxed purchases it was downward (see Y coefficient in Supplemental Table 3).

4. Discussion

On average, over the two years after the taxes implementation, % taxed food purchases declined 6.0% beyond what would have been expected. We found that the rate of decline in % taxed food purchases accelerated in the second year after tax implementation. The evaluation of the 2-year Mexico SSB tax also showed larger declines in the purchases of taxed beverages in the second year post-implementation; from −5.5% in 2014 to −9.7% in 2015 (Colchero et al., 2017a). It is possible that the reasons for larger declines in the second year are due to what is called the habituation or addiction effect by economists (Jensen and Smed, 2013), which has been shown for tobacco, alcohol, and illicit drugs (Becker and Murphy, 1988; Chaloupka et al., 2012; Gallet, 2007; Grossman and Chaloupka, 1998; Gruber and Koszegi, 2001). Another possibility is that over time, consumers continued to shift preferences as a result of the public health campaigns on obesity and diabetes. More research with longer follow-up periods will be needed to understand the mechanisms behind changes in consumer purchasing decisions in response to the tax.

Because in 2015 the volume of both taxed and untaxed purchases decreased, we focused instead in the change of % taxed. The declines that we found in the volume of purchases in 2015 reflect the trends of the Nielsen Mexico sample, and the observed results might not reflect the national trends. The Nielsen sample is urban, the purchases represent only packaged purchases, and similar to other consumer panel surveys, it is more likely that items purchased and consumed away-from-home are less captured. Another evaluation of the junk food's tax using sales data from a manufacturer's industry survey found that in 2014 compared to the pre-tax period (2007–2013) the was a decreased in the volume of sales of −5.57% and in 2015 the decrease was −4.35% (Colchero et al., 2017a).

Post-tax changes in purchases varied by pre-tax purchasing behaviors. The healthy group did not change purchases of % taxed foods in the post-tax period relative to the counterfactual, suggesting that when a household already has a healthy purchasing pattern, a tax on

Table 2
Adjusted mean observed and counterfactual volume of taxed/untaxed and % taxed purchases in 2014, 2015, and 2014–2015.

	Post-tax counterfactual		Post-tax observed		Observed vs. counterfactual	
	Taxed/untaxed, g/capita/month	% Taxed (95% CI)	Taxed/untaxed (g/capita/month)	% Taxed (95% CI)	Absolute difference in % taxed (95% CI)	Relative difference in % taxed (95% CI)
All						
2014	436/1257	26.4 (25.7, 27)	418/1292	25.1 (24.6, 25.6)	**−1.3 (−1.8, −0.8)**	**−4.8% (−6.6, −3.0)**
2015	414/1195	26.5 (25.6, 27.4)	355/1137	24.5 (24.0, 25.1)	**−2.0 (−2.8, −1.1)**	**−7.4% (−10.3, −4.5)**
2014 and 2015	426/1228	26.4 (25.7, 27.2)	389/1218	24.8 (24.3, 25.3)	**−1.6 (−2.2, −1.0)**	**−6.0% (−8.2, −3.8)**
Low (low taxed – low untaxed)						
2014	184/628	24.3 (23.2, 25.3)	194/683	23.4 (22.6, 24.3)	−0.8 (−1.8, 0.2)	−3.3% (−7.3, 0.7)
2015	175/604	24.8 (23.2, 26.4)	183/658	22.9 (21.9, 23.9)	**−1.9 (−3.4, −0.3)**	**−7.6% (−13.4, −1.8)**
2014 and 2015	180/617	24.5 (23.2, 25.8)	189/671	23.2 (22.4, 24.0)	**−1.3 (−2.5, −0.1)**	**−5.3% (−9.9, −0.7)**
Healthy (low taxed – high untaxed)						
2014	240/1514	14.4 (13.3, 15.5)	239/1546	14.0 (13.2, 14.7)	−0.4 (−1.4, 0.6)	−2.9% (−9.6, 3.9)
2015	227/1447	14.2 (12.5, 16.0)	221/1339	14.7 (13.8, 15.7)	0.5 (−1.1, 2.0)	3.3% (−8.2, 14.7)
2014 and 2015	234/1482	14.3 (12.9, 15.7)	231/1447	14.3 (13.6, 15.1)	0.0 (−1.2, 1.2)	0.1% (−8.4, 8.5)
Unhealthy (high taxed – low untaxed)						
2014	526/811	39.9 (38.1, 41.6)	475/893	35.6 (34.4, 36.8)	**−4.3 (−5.7, −2.8)**	**−10.7% (−14.1, −7.3)**
2015	495/781	39.6 (36.8, 42.4)	410/840	34.1 (32.6, 35.6)	**−5.6 (−8.3, −2.8)**	**−14.0% (−20.2, −7.9)**
2014 and 2015	511/797	39.8 (37.6, 41.9)	444/868	34.9 (33.7, 36.1)	**−4.9 (−6.8, −3.0)**	**−12.3% (−16.6, −8.0)**
High (high taxed – high untaxed)						
2014	703/1915	27.5 (26.7, 28.4)	669/1925	26.6 (25.9, 27.3)	**−0.9 (−1.6, −0.2)**	**−3.4% (−5.7, −1.0)**
2015	669/1826	27.4 (26.2, 28.6)	543/1638	25.9 (25.2, 26.6)	**−1.5 (−2.6, −0.4)**	**−5.5% (−9.4, −1.7)**
2014 and 2015	687/1872	27.5 (26.5, 28.5)	609/1788	26.3 (25.6, 26.9)	**−1.2 (−2.0, −0.4)**	**−4.4% (−7.2, −1.5)**

Source: Authors' own analyses and calculations based in part on data reported by Nielsen through its Mexico Consumer Panel Service for food and beverages or the January 2012 to December 2015. Nielsen data is licensed from The Nielsen Company, 2017. The conclusions drawn from the Nielsen data are those of the authors and do not reflect the views of Nielsen. Nielsen is not responsible for and was not involved in analyzing and preparing the results reported herein. Weights provided by Nielsen to represent populations in areas with > 50,000 inhabitants.
Bold values indicate significance at $p < 0.05$.

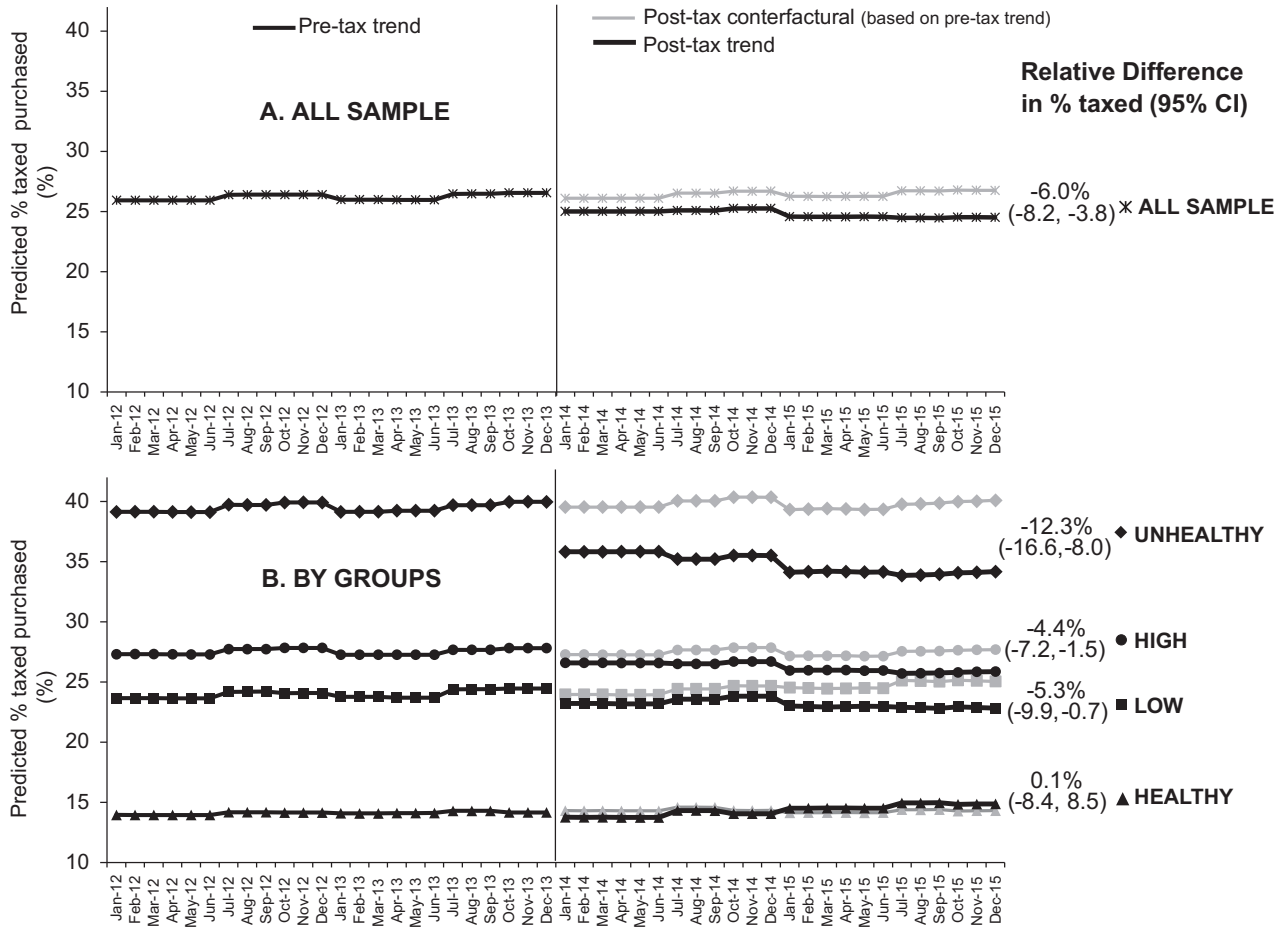

Fig. 2. Monthly trends in predicted % taxed foods purchased of A) Overall sample and B) By pre-tax household food purchasing group. Source: Authors' own analyses and calculations based in part on data reported by Nielsen through its Mexico Consumer Panel Service for food and beverages or the January 2012 to December 2015. Nielsen data is licensed from The Nielsen Company, 2017. The conclusions drawn from the Nielsen data are those of the authors and do not reflect the views of Nielsen. Nielsen is not responsible for and was not involved in analyzing and preparing the results reported herein.

nonessential foods does not affect their purchasing behavior. On the other hand, the Unhealthy group, which had high purchases of taxed foods and low purchases of untaxed foods and hence the highest proportion of taxed foods from total purchases (almost 40% taxed) before the tax; moved the most in the expected direction: they showed the largest relative decline in their purchases of % taxed foods (−12.3%). The Low and High group had a similar relative decline in their purchases of % taxed foods (−5.3 and −4.4%); yet, before the tax the % taxed foods was 24.5 and 27.5% for the Low and High group respectively and the total volume of purchases of the High group was 3 times that of the Low group (909 vs 2731 g/capita/month). These results seem counterintuitive because, compared to the Low group, the High group had a larger % taxed foods and a larger total volume of purchases before the tax, and hence one would had expected a larger decrease in % taxed foods from this group. One possibility is that high-SES households were more likely to be in the High-purchasing group. High-SES households tend to be less sensitive to price increases (Andreyeva et al., 2010; Colchero et al., 2015; Powell and Chaloupka, 2009). Moreover, the first-year tax evaluation study showed that low-income households decreased their purchases of taxed food purchases 10.2%, whereas higher-income households did not change. However, as our results suggest, SES is not the only important determinant, and the level of purchasing before the tax is also key. We found that the distribution of SES was very similar in the Low and the Unhealthy group (higher proportion of low-SES); whereas the distribution of SES was very similar in the Healthy and High group (lower proportion of low-SES); yet the response to the tax was completely different between the Low and Unhealthy and between the Healthy and High.

In our study we did not analyze changes in prices. Previous analyses have found that in urban areas the increase in price after the tax was close to 8% (Colchero et al., 2017a), but in rural areas this was 2–4% only (Colchero et al., 2017b). This suggests that there is variability in the pass-through of the tax to consumers, and it is possible that our household's groups were exposed to different prices.

An important caveat when considering the potential effects of this tax by pre-tax purchasing behavior is that our dataset captures only packaged food purchases. Households could have increased their purchases of unpackaged untaxed foods such as fruits and vegetables purchased at a market, but that change would not be reflected in the current study. In addition, this data does not reveal any changes in households' food purchasing from away-from-home sources, such as restaurants or street vendors. An understanding of total dietary shifts will be essential to estimate the potential impact of these taxes for obesity prevention.

In addition, the primary limitation of this study is the inability to assign causality due to the lack of randomized exposure to the tax.

5. Conclusion

In conclusion, the effects of the nonessential food tax continued during the second-year of the tax and were also greater for households who showed greater preferences for taxed foods prior to the tax. This heterogeneity of effect will also be important to consider when examining the full magnitude of these taxes on downstream rates of obesity and diabetes.

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Transparency document

The Transparency document associated with this article can be found, in the online version.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.ypmed.2017.07.009.

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