Changes in food purchases after the Chilean policies on food labelling, marketing, and sales in schools: a before and after study

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Summary

Background In 2016, Chile implemented a unique law mandating front-of-package warning labels, restricting marketing, and banning school sales for products high in calories, sodium, sugar, or saturated fat. We aimed to examine changes in the calorie, sugar, sodium, and saturated fat content of food and beverage purchases after the first phase of implementation of this law.

Methods This before and after study used longitudinal data on food and beverage purchases from 2381 Chilean households from Jan 1, 2015, to Dec 31, 2017. Nutrition facts panel data from food and beverage packages were linked to household purchases at the product level using barcode, brand name, and product description. Nutritionists reviewed each product for nutritional accuracy and categorised it as high-in if it contained added sugar, sodium, or saturated fat and exceeded phase 1 nutrient or calorie thresholds, and thus was subject to the labelling, marketing, and school regulations. Using fixed-effects models, we examined the mean nutrient content (overall calories, sugar, saturated fat, and sodium) of purchases in the post-policy period compared to a counterfactual scenario based on pre-policy trends.

Findings Compared with the counterfactual scenario, overall calories purchased declined by 16·4 kcal/capita/day (95% CI –27·3 to –5·6; p=0·0031) or 3·5%. Overall sugar declined by 11·5 kcal/capita/day (–14·6 to –8·4; p<0·0001) or 10·2%, and saturated fat declined by 2·2 kcal/capita/day (–3·8 to –0·5; p=0·0097) or 3·9%. The sodium content of overall purchases declined by 27·7 mg/capita/day (–46·3 to –9·1; p=0·0035) or 4·7%. Declines from high-in purchases drove these results with some offset by increases in not-high-in purchases. Among high-in purchases, relative to the counterfactual scenario, there were notable declines of 23·8% in calories purchased (–49·4 kcal/capita/day, 95% CI –55·1 to –43·7; p<0·0001), 36·7% in sodium purchased (–96·6 mg/capita/day,–105·3 to –87·8; p<0·0001), and 26·7% in sugar purchased (–20·7 kcal/capita/day, –23·4 to –18·1; p<0·0001).

Interpretation The Chilean phase 1 law of food labelling and advertising policies were associated with reduced high-in purchases, leading to declines in purchased nutrients of concern. Greater changes might reasonably be anticipated after the implementation of phases 2 and 3.

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Introduction

Globally, many governments are implementing policies to change the food environment as a strategy to reduce excess consumption of unhealthy packaged foods, improve diets, and prevent increases in obesity and non-communicable disease prevalence. Three important and increasingly common policy strategies recommended by WHO are front-of-package labels on unhealthy foods and beverages, restrictions on marketing these foods to children, and restricting the sales of these products in schools.[1–3]

However, evidence of the effect of these policies is nascent, partly because mandatory implementation of these policies by federal governments is very new, so evaluations are sparse. For example, in 2016, Chile was the first country to implement a mandatory, national front-of-package nutrient warning label policy. Other countries have followed with similar labelling laws, but evaluation data are not yet available. Similarly, although it is established that food marketing to children leads to increased preferences for and intake of unhealthy foods,[4] little is known about whether mandatory restrictions on food marketing to children can reduce this impact, as most evidence stems from voluntary industry initiatives with little effect and few countries have rigorous national policies.[5] Finally, although the literature shows that school food environment policies can improve dietary intake,[6] data on the effect of national bans on school sales of unhealthy foods are also sparse.

Despite growing consensus that multiple policy actions are crucial for improving diets and promoting health,

Research in context

Evidence before this study

To prevent further increases in nutrition-related, non-communicable diseases, Chile was the first country to implement a set of mutually reinforcing policies that mandated front-of-package warning labels, restrictions on marketing to children, and banning in-school sales of packaged foods and beverages high in calories and added sugar, sodium, and saturated fat. Although previous data from Chile showed a decline in calories from beverage purchases after the law was implemented, it is important to understand changes in calories or nutrients from total purchases—that is, foods and beverages combined—to understand the potential impact on health. To consider the evidence, we searched the World Cancer Fund's NOURISHING database on food policies for relevant policies on front-of-package labelling, food marketing to children, and school sales bans. We found no examples other than in Chile of a country that has implemented this complete set of policies on unhealthy foods and drinks.

Added value of this study

We found important reductions in calories, sugar, sodium, and saturated fat from unhealthy so-called high-in food and beverage purchases after implementation of the Chilean set of laws, which were partly offset by an increase in so-called not-high-in purchases. These changes led to declines in overall purchases of calories and nutrients of concern. The declines in nutrients of concern were greater than those observed in previous data for beverages alone, showing the greater potential for impact when policies include both beverages and foods in their scope. Similarly, the declines were greater than those typically observed by standalone policies (eg, sugar-sweetened beverage taxes) in the Latin American region, showing the importance of multi-component policies in driving changes in food purchases.

Implications of all the available evidence

Our findings emphasise the potential public health impact of multi-component food policies, and the importance of including full food supply approaches that apply to both beverages and foods. Further research is needed to understand how declines in purchased calories and nutrients of concern translate into changes in diet and health in the long term.

most countries have implemented only one policy at a time—with a particular focus on sugar-sweetened beverage taxes—so there is little understanding about the joint impact of marketing, labelling, and school food policies implemented together.

See Online for appendix

The Chilean law of food labelling and advertising, implemented in three progressively strict phases beginning in 2016, offers a unique opportunity to examine the joint effect of these policies, as this policy includes not only the first mandatory warning label law, but also imposes comprehensive marketing restrictions and prohibits sales and promotion in schools for all foods and beverages high in added sugar, sodium, saturated fat, or calories. The Chilean law also provides an opportunity to understand the policies' potential impact on nutritional disparities in food purchases. In particular, the front-of-package warning label law aims to make it easier to identify products high in nutrients of concern, which might have a greater impact among consumers with lower health and nutrition literacy, who are less likely to use or understand the complex back-of-package nutrition label information.[7]

We aimed to examine changes in the calorie, sugar, sodium, and saturated fat content of food and beverage purchases after the first phase of implementation of the Chilean policies.

Methods

Study design and participants

We used longitudinal data on household food and beverage purchases from Jan 1, 2015, to Dec 31, 2017, from Kantar WorldPanel Chile, an open cohort consumer panel study of households located in cities (population greater than 20 000).[8,9] Compared with the overall Chilean population, the Kantar sample is similarly geographically distributed, but with larger households and a higher proportion of households with tertiary education (appendix p 1).

We investigated an unbalanced panel of 2381 households with a median follow-up of 35 months, providing 67 890 household-month observations. Data on each packaged product[8] purchased include volume (mL) or weight (g), barcode, price per unit, retail outlet, brand, package size, and date.

Our dataset also contained self-reported household information including size, composition (age and gender of each member), assets (number of rooms, bathrooms, and cars), geographical region, age of the main shopper, head of household's (typically the primary earner) education level, and socioeconomic status (as defined by the market and public opinion research association Asociación de Investigadores de Mercado y Opinión Pública de Chile and calculated based on household assets, head of household's education, and access to goods and services). Two households had missing demographic data and were excluded from the study.

This study was exempt from review by the University of North Carolina, Chapel Hill Institutional Review Board (IRB) as it used secondary, deidentified data. The study was reviewed and approved by the University of Chile IRB.

The Chilean regulation

The Chilean law of food labeling and advertising requires packaged foods and beverages containing added sugar, sodium, or saturated fat and exceeding set thresholds for these nutrients or for overall calorie content to carry front-of-package warning labels—black octagon(s) with the words high-in sugar, sodium, saturated fat, and/or calories, whichever applies. These products are also subject to child-directed marketing restrictions and banned from sale or promotion in schools and nurseries. To accommodate the food industry's request for flexibility in implementation, the policy was designed for phased implementation with increasingly restrictive nutrient thresholds implemented in June, 2016 (phase 1), June, 2018 (phase 2), and June, 2019 (phase 3; appendix p 2).[10]

Nutritional data and categorisation by food group and regulation status

Nutrition facts panel (NFP) data from packages were linked to household purchases at the product level using barcode, brand name, and product description.[8,11–13] We linked pre-policy purchases to NFP data collected in the first quarter of 2015 and 2016, and post-policy purchases to data collected in the first quarter of 2017. Nutritionists reviewed each product for nutritional accuracy and categorised it as high-in if it contained added sugar, sodium, or saturated fat and exceeded phase 1 nutrient or calorie thresholds, and thus was subject to the labelling, marketing, and school regulations.[10] Foods and beverages were grouped based on nutritional profile and typical patterns of consumption (appendix p 3).

Some groups were excluded from our analysis because of absent or inconsistent data collected by Kantar (energy drinks, salty snacks, and candy) or insufficient NFP (loose-leaf teas and packaged tea bags). Purchases of loose produce or in bulk (eg, bread by the piece or grains purchased by weight) were also excluded because volume or weight were unavailable. However, compared with national sales data, the Kantar dataset had high representation of top brands and was similar in the contribution of most food groups to total sales (appendix pp 4–5).

Outcomes

All data were aggregated at the monthly level and analysed for calories (kcal), sugar (kcal), saturated fat (kcal), and sodium (mg) purchased per capita per day. We considered overall calories per capita per day for combined food and beverage purchases as the main outcome for the potential effect of the policy on obesity prevention. We also examined calories and nutrients purchased from high-in foods and beverages separately from not-high-in foods and beverages, as well as by food and beverage subgroup.

Covariates included the age of the household's main shopper (continuous), household composition (a set of continuous variables, each with the number of people in the following age categories: children aged 0–1 years, children aged 2–5 years, children aged 6–13 years, adolescents aged 14–18 years by gender, female adults older than 18 years, and male adults older than 18 years), and monthly regional unemployment rate.[14] As a proxy for socioeconomic status, we included head of household's educational level (less than high school, high school, or more than high school) as well as household assets (created using a factor analysis including number of bedrooms, number of bathrooms, and number of cars, categorised as tertiles, and specified in the model as a set of indicator variables), consistent with our previous evaluation of the Chilean law.[8] Finally, we included calendar month indicator variables to adjust for seasonality and a continuous month variable (1–36) to account for any linear time trend.

Statistical analyses

We examined household sociodemographic characteristics in 2015, 2016, and 2017. We compared unadjusted mean nutrients and calories of purchases and proportions of consumers for high-in and "not-high-in" products and by food and beverage subcategory in the pre-policy and post-policy periods, using ordinary least squares to obtain cluster-robust standard errors.

Consistent with our previous evaluation,[8] we included 18 months of data before and after policy implementation to have balanced pre-policy and post-policy periods while maximising available data. We defined the pre-policy period as Jan 1, 2015, to June 30, 2016, and the post-policy period as July 1, 2016, to Dec 31, 2017.

For our main analyses, we used a pre-post modelling approach to examine changes in nutrient contents of overall food purchases before and after the policy was implemented. We used a fixed-effects linear regression model with a binary variable for the policy period and its interaction with a linear time trend. We compared purchases in the post-policy period to a counterfactual, or what purchases would have been expected in the post-policy period based on pre-policy trends.[11,12,15,16] We constructed this counterfactual by predicting purchases in the post-policy period based on pre-policy trends.

To test whether policy-related changes in purchases varied by socioeconomic status, we added an interaction of education or assets with every variable. The variable of interest was the triple interaction of socioeconomic status with the policy period and time trend. We also compared the difference between the post-policy predicted and counterfactual means across levels of education and assets. All adjusted analyses used SEs clustered at the household level and controlled for the covariates.

We examined the robustness of the results on overall calories to variations in the model specification (eg, inclusion of covariates) and underlying data (eg, linking of purchases to NFP; appendix pp 11–12).

All statistical analyses were done using Stata version 16. The prespecified analysis plan was registered with Open Science Framework after data were collected but before analysis. Changes to prespecified main analyses and rationale for these changes are documented in the appendix (p 6).

For the **prespecified analysis plan** see https://osf.io/mj8az/

	2015	2016	2017
Number of households	2099	2076	2099
Number of household-month observations	22 897	22 881	22 112
Head of household education			
Less than high school	652 (31%)	584 (28%)	575 (27%)
High school	793 (38%)	820 (39%)	815 (39%)
College or greater	654 (31%)	672 (32%)	709 (34%)
Household assets index			
Low	788 (38%)	750 (36%)	781 (37%)
Middle	635 (30%)	648 (31%)	649 (31%)
High	676 (32%)	678 (33%)	669 (32%)
Household composition, by sex and age			
Children 0–1 year	0·12 (0·35)	0·08 (0·28)	0·03 (0·19)
Children 2–5 years	0·34 (0·58)	0·33 (0·57)	0·34 (0·58)
Children 6–13 years	0·53 (0·72)	0·53 (0·71)	0·54 (0·72)
Children, female, age 14–18 years	0·18 (0·44)	0·17 (0·41)	0·16 (0·39)
Children, male, age 14–18 years	0·17 (0·41)	0·17 (0·41)	0·18 (0·43)
Women	1·53 (0·73)	1·55 (0·76)	1·60 (0·80)
Men	1·21 (0·78)	1·22 (0·81)	1·28 (0·84)
Monthly regional unemployment	6·3% (1·0)	6·5% (1·2)	6·7% (1·1)

Data are n, n (%), or mean (SD).

Table 1: **Sociodemographic characteristics of the Kantar WorldPanel Chile sample, 2015–17**

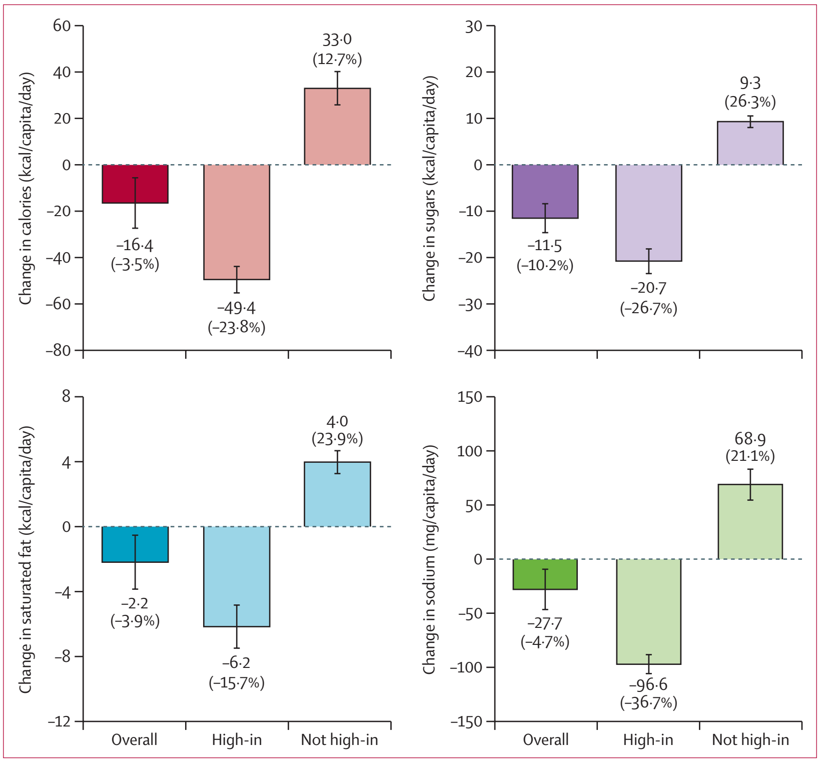

Figure 1: **Mean differences in nutrient content between estimated adjusted post-policy purchases and estimated adjusted counterfactual scenario post-policy total food and beverage purchases**
Overall estimates are derived from fixed effects models comparing post-policy nutrient content of purchases to counterfactual post-policy nutrient content of purchases based on pre-policy trends. Purchase data provided by Kantar WorldPanel Chile. Error bars indicate 95% CIs.

Role of the funding source
The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results
Demographic characteristics of the study sample are shown in table 1. Before the introduction of the Chilean law of food labelling and advertising, there was a slight downward time trend for overall, high-in, and not-high-in food and beverage purchases (p=0·0061 for the pre-regulation linear time trend; appendix p 13). Although the proportion of households who bought any high-in product or who bought high-in food remained at almost 100% after introduction of the law, the proportion of households who bought high-in beverages dropped by 12 percentage points (94% to 81%; p<0·0001; appendix p 7).

We found few overall differences in the proportion of consumers of specific food groups pre-implementation of the law versus post-implementation of the law (differences all <4 percentage points; appendix p 8). However, we found some differences by high-in status. Compared with the pre-policy period, the largest decreases in high-in purchases were for industrialised fruit and vegetable juices (–47%), dairy-based beverages and substitutes (–31%), condiments and sauces (–33%), meat, poultry, and meat substitutes (–11%), breakfast cereals (–11%), and sweets and non-grain-based desserts (–8%; p<0·0001 for all). The proportion of consumers of not-high-in products from these food groups increased, typically by a similar or lesser magnitude.

Compared with the counterfactual scenario in which the policy was not enacted, overall calories purchased declined by 16·4 kcal/capita/day (95% CI –27·3 to –5·6; p=0·0031) or 3·5% (figure 1; appendix p 9). Overall, purchased sugar declined by 11·5 kcal/capita/day (–14·6 to –8·4; p<0·0001) or 10·2%, and saturated fat declined by 2·2 kcal/capita/day (–3·8 to –0·5; p=0·0097) or 3·9%. The sodium content of overall purchases declined by 27·7 mg/capita/day (–46·3 to –9·1; p=0·0035) or 4·7%.

These results were driven largely by declines in high-in food and beverage purchases. Relative to the counterfactual scenario, high-in calories purchased declined by 49·4 kcal/capita/day (95% CI –55·1 to –43·7; p<0·0001) or 23·8%, whereas purchased sugar from high-in purchases declined by 20·7 kcal/capita/day (–23·4 to –18·1; p<0·0001) or 26·7%, and purchased saturated fat from high-in purchases declined by 6·2 kcal/capita/day (–7·5 to –4·8; p<0·0001) or 15·7%. Purchases of high-in sodium products declined by 96·6 mg/capita/day (–105·3 to –87·8; p<0·0001), or 36·7%, relative to the counterfactual scenario.

By contrast, purchases of calories, sugar, saturated fat, and sodium from not-high-in foods and beverages increased, although not enough to offset the declines from high-in products. Not-high-in calories purchased increased by 33·0 kcal/capita/day (95% CI 25·8 to 40·2;

p<0·0001), or 12·7%, sugar from not-high-in purchases increased by 9·3 kcal/capita/day (8·0 to 10·5; p<0·0001) or 26·3%, and saturated fat from not-high-in purchases increased by 4·0 kcal/capita/day (3·3 to 4·7; p<0·0001) or 23·9%. Sodium from not-high-in products increased by 68·9 mg/capita/day (54·6 to 83·2; p<0·0001) or 21·1%, relative to the counterfactual scenario.

Food-specific results aligned with those from combined foods and beverages, with significant declines in purchased sugar, sodium, and saturated fat. However, calories from food purchases alone did not decline significantly (figure 2).

Overall calories purchased declined by 6·4 kcal/capita/day (95% CI –15·4 to 2·6; p=0·16) or 1·7%. Overall, purchased sugar declined by 2·4 kcal/capita/day (–3·7 to –1·1; p=0·00032) or 5·4%, and saturated fat declined by 1·7 kcal/capita/day (–3·1 to –0·2; p=0·023) or 3·6%. The sodium content of overall purchases declined by 24·3 mg/capita/day (–41·9 to –6·6; p=0·0070) or 4·6%.

Calories from high-in food purchases decreased by 33·1 kcal/capita/day (95% CI –37·7 to –28·6, p<0·0001) or 21·3% relative to the counterfactual scenario. Declines in sodium from high-in foods were large at –89·4 mg/capita/day (–97·9 to –80·9; p<0·0001), or –36·3% relative to the counterfactual scenario. Sugar from high-in food purchases declined by 6·7 kcal/capita/day (–7·8 to –5·7; p<0·0001), or 22·6% relative to the counterfactual scenario, and high-in saturated fat purchases declined by 5·4 kcal/capita/day (–6·7 to –4·1; p<0·0001) or 14·2% relative to the counterfactual scenario. As with total purchases, these declines among high-in food purchases were partly offset by not-high-in purchases. Purchases of calories, sugar, saturated fat, and sodium from not-high-in foods and beverages increased, although not enough to offset the declines from high-in products. Not-high-in calories purchased increased by 26·8 kcal/capita/day (20·6 to 32·9; p<0·0001), or 12·7%, sugar from not-high-in purchases increased by 4·3 kcal/capita/day (3·7 to 4·9; p<0·0001) or 29·4%, and saturated fat from not-high-in purchases increased by 3·8 kcal/capita/day (3·3 to 4·2; p<0·0001) or 46·6%. Sodium from not-high-in products increased by 65·2 mg/capita/day (51·6 to 78·7; p<0·0001) or 23·5%, relative to the counterfactual scenario.

Overall, beverage purchases had significant declines in calories, sugar, saturated fat, and sodium (figure 3). We found a 10·0 kcal/capita/day decline from all beverage purchases (95% CI –13·4 to –6·6; p<0·0001), or 9·9% relative to the counterfactual scenario, and a 9·1 kcal/capita/day decline in sugar (–11·5 to –6·6; p<0·0001), or 13·2%, relative to the counterfactual scenario. We found a 0·5 kcal/capita/day decline in saturated fat overall (–1·0 to 0·0; p=0·048) or 5·6%, and a 3·4 mg/capita/day overall decline in sodium (–5·8 to –1·1; p=0·0045) or 5·2%, compared with the counterfactual scenario.

As with food purchases, the declines in beverage calories and sugar were driven by reduced high-in beverage purchases. High-in beverage purchases declined by 16·3 kcal/capita/day (95% CI –18·7 to –13·9; p<0·0001), or 31·3% relative to the counterfactual scenario. High-in sugar beverage purchases declined by 14·0 kcal/capita/day (–16·2 to –11·8; p<0·0001), or 29·2% relative to the counterfactual. High-in saturated fat beverage purchases declined by 0·7 kcal/capita/day (–0·8 to –0·6; p<0·0001) or 80·3%, and high-in sodium purchases declined by 7·2 mg/capita/day (–8·0 to –6·3; p<0·0001) or 43·3%, relative to the counterfactual scenario. As with foods, these declines were partly offset by increases in not-high-in beverage purchases. Not-high-in calories purchased increased by 6·3 kcal/capita/day (4·1 to 8·5; p<0·0001), or 12·6%, sugar from not-high-in purchases increased by 4·9 kcal/capita/day (4·0 to 5·9; p<0·0001) or 24·1%, and saturated fat from not-high-in purchases increased by 0·2 kcal/capita/day (–0·3 to 0·7; p=0·43) or 2·4%. Sodium from not-high-in products increased by 3·7 mg/capita/day (1·6 to 5·9; p=0·00059) or 7·6%, relative to the counterfactual scenario.

We found no significant interactions between the time trend, the post-policy period, and education or assets for overall or high-in calories purchased, and most pairwise comparisons were not significant (table 2). However, our results suggest that more educated households

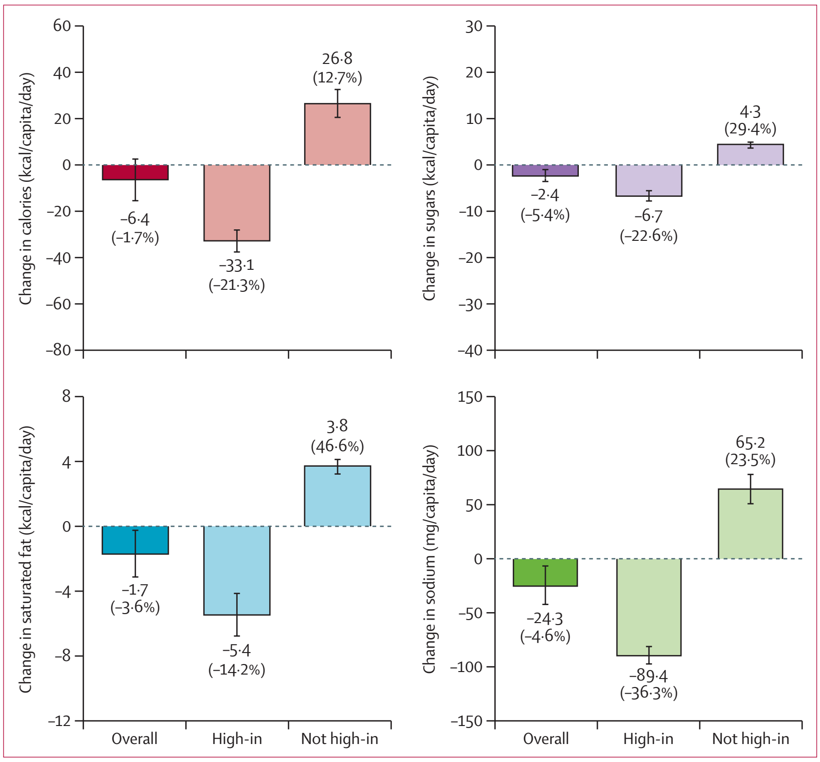

Figure 2: **Mean differences in nutrient content between estimated adjusted post-policy purchases and estimated adjusted counterfactual scenario post-policy food purchases**
Overall estimates are derived from fixed effects models comparing post-policy nutrient content of purchases to counterfactual post-policy nutrient content of purchases based on pre-policy trends. Purchase data provided by Kantar WorldPanel Chile. Error bars indicate 95% CIs.

showed larger declines in both overall and high-in calories purchased. We found a statistically significant interaction for not-high-in foods, wherein the least educated households showed the largest increases in not-high-in calories purchased (appendix p 10). By contrast, the pattern of results suggest that compared with households with higher assets, households with lower assets had larger decreases in calories purchased overall and from high-in products, and had smaller increases in calories purchased from not-high-in foods (appendix p 10).

Our findings were robust (appendix pp 11–12), although there were some differences in estimates and precision by model specification, by NFP linkage, and by time window included.

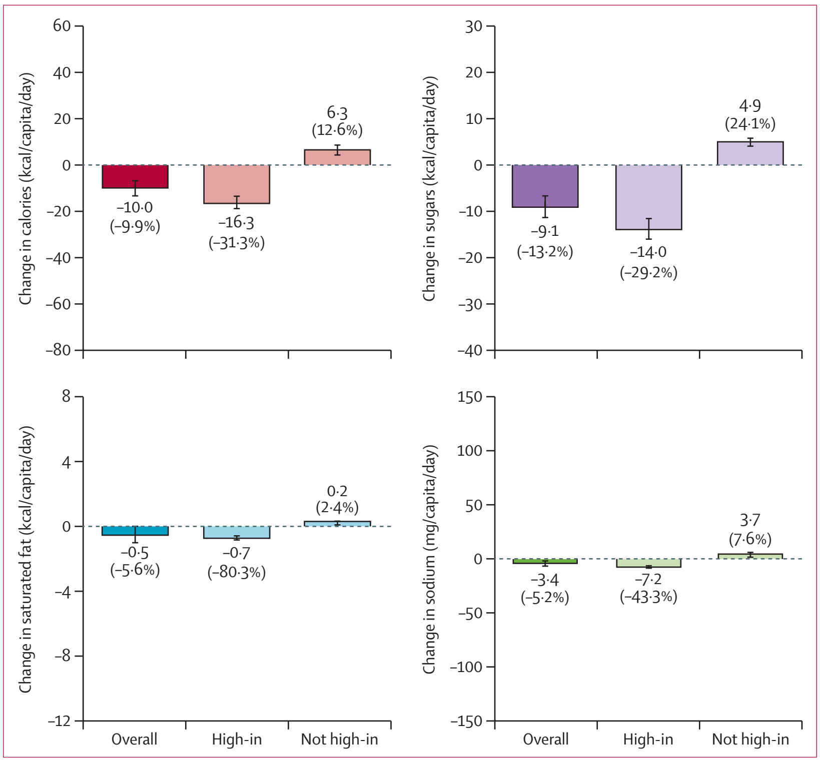

***Figure 3:* Mean differences in nutrient content between estimated adjusted post-policy purchases and estimated adjusted counterfactual post-policy beverage purchases**

Overall estimates are derived from fixed effects models comparing post-policy nutrient content of purchases to counterfactual post-policy nutrient content of purchases based on pre-policy trends. Purchase data provided by Kantar WorldPanel Chile. Error bars indicate 95% CIs.

Discussion

After implementation of the first phase of Chile's law of food labelling and advertising, we found significant decreases in overall purchases of calories, sugar, saturated fat, and sodium, compared with the counterfactual scenario if the law had not been introduced. These declines were largely driven by reductions in high-in food and beverage purchases, with partial compensation from increases in not-high-in purchases.

This study builds on previous evaluations of the Chilean law, which found that the law improved the nutritional content of the food supply,[17] reduced unhealthy food marketing to children,[18,19] reduced availability of unhealthy foods in schools,[20] and helped people better identify unhealthy products and discouraged their consumption.[21] Although we were not able to disentangle the effects of the labelling, marketing, and school components of the law in this study, the body of results from the previous evaluations shows how each aspect of the law contributed to changes in the food environment and behaviour. We believe our study results emphasise the need to implement multi-component policies. Our results only reflect changes after phase 1 of implementation. We anticipate larger changes after implemen-

	Overall				High-in				Not high-in			
	Absolute difference (95% CI)	p value	$p_{interaction}$	Relative difference	Absolute difference (95% CI)	p value	$p_{interaction}$	Relative difference	Absolute difference (95% CI)	p value	$p_{interaction}$	Relative difference
Education												
Less than high school	–7·6 (–29·3 to 14·0)	0·49	0·095	–1·7%	–46·8 (–57·5 to –36·1)	<0·0001	0·34	–23·1%	39·2 (24·5 to 53·9)	<0·0001	0·013	15·3%
High school	–13·9 (–29·6 to 1·8)	0·083		–3·1%	–43·2 (–51·4 to –34·9)	<0·0001		–21·8%	29·2 (18·9 to 39·6)	<0·0001		11·7%
College or greater	–28·1 (–47·8 to –8·5)	0·0050		–5·6%	–59·3* (–70·1 to –48·4)	<0·0001		–26·5%	31·1 (18·6 to 43·6)	<0·0001		11·3%
Household assets												
Low	–22·3 (–42·1 to –2·5)	0·027	0·93	–4·7%	–52·4 (–62·2 to –42·6)	<0·0001	0·23	–25·2%	30·1 (16·7 to 43·5)	<0·0001	0·27	11·6%
Middle	–15·6 (–34·0 to 2·8)	0·097		–3·5%	–49·5 (–59·1 to –40·0)	<0·0001		–24·6%	34·0 (21·5 to 46·4)	<0·0001		13·2%
High	–11·8 (–30·3 to 6·7)	0·21		–2·4%	–46·3 (–56·6 to –36·0)	<0·0001		–21·6%	34·5 (22·7 to 46·2)	<0·0001		13·1%

Estimates derived from fixed effects models comparing post-policy nutrient content of purchases to counterfactual post-policy nutrient content of purchases based on pre-policy trends. Covariates included age of household's main shopper, head of household education level, household composition, household assets, and monthly regional unemployment rate, along with indicator variables for calendar months, a linear time trend, an indicator variable for the policy period, and the interaction of time trend, policy period, and household education or assets. Pairwise comparisons were made for each level of education and household assets. pinteraction is from Wald tests of the equality of the interaction for policy period, linear time trend, and education or assets. *The only statistically significant pairwise comparison was between college and greater and high school education for high-in calories purchased (p=0·020).

***Table 2:* Mean differences between the estimated adjusted post-policy calories purchased from total foods and beverages and estimated adjusted counterfactual post-policy food purchases by educational level and household assets**

tation of phases 2 and 3, with their increasingly strict nutrient thresholds plus an expansion of the marketing regulation to prohibit all television advertising for high-in products from 06:00 h and 22:00 h.[22]

Our findings are consistent with an analysis of purchase data from Walmart-Chile by Barahona and colleagues,[23] who found an overall decrease in sugar and calorie purchases of 7–9% among Walmart customers over 2 years after the Chilean policy was implemented.[23] Our results are also consistent with a meta-analysis of warning label experiments,[24] which included a study in Canada that examined high-in warnings similar to the Chilean warning[25] and found very similar decreases in overall calories, sugar, and sodium purchased. The consistency of these findings across study designs and populations provides support for the effect of these policies on food purchases.

These results highlight the importance of policies that apply to both beverages and foods. Although Chile is one of the world's top consumers of sugar-sweetened-beverages,[26] beverages comprise only around 10% of daily calorie intake.[27] Indeed, post-implementation calories purchased from high-in foods showed greater absolute decreases than high-in beverages, compared with their counterfactual estimates for if the policy had not been introduced. We also found differential changes in nutrients purchased from foods versus beverages, with larger absolute reductions in sugar coming from beverages, whereas foods had larger absolute reductions in sodium and saturated fat. Importantly, results for foods might be underestimated given our inability to include all packaged foods (eg, salty snacks or candy) because of the absence of consistently collected data on this category in Kantar. Regardless, our results highlight the need to focus policies on all foods and beverages, not just beverages.

Declines in high-in purchases were partly offset by increases in not-high in purchases. Among foods, this shift resulted in a non-significant change in overall calories purchased. This result is comparable to those of Barahona and colleagues,[23] who also found a pattern of consumers shifting from high-in to not-high in purchases. There was also little net change in purchases from specific food groups, suggesting that consumers shifted (either by choice or because of reformulation) from high-in to not-high-in products within a category rather than changing the type of food or drink they purchased.

In terms of differences by socioeconomic status, our results were complex. Although statistical tests showed mostly non-significant results for education, our results suggested that highest-educated households had a greater reduction overall and in high-in calories compared with households with lower levels of education. This result might be driven by greater high-in purchases by households with higher levels of education before implementation of the Chilean law of food labelling and advertising and is consistent with sugar-sweetened beverage tax evaluations that found greater effects among those who buy more of these products.[15,28] This finding aligns with previous literature that suggested a differential response to nutritional information by educational status.[29] By contrast, we found that households with the lowest assets had larger declines in overall and high-in calories purchased compared with households with high levels of assets, but smaller increases in not-high-in calories, an interesting finding since households with lower assets purchased fewer calories in the pre-policy period. More research is needed to understand the drivers of this potential differential effect (eg, if prices of high-in products changed), and additional socioeconomic status measures, such as household income, could be investigated.

Further research is needed to understand how industry has responded to the law, including changes in price, product reformulation, and food marketing, as well as to monitor potential unintended consequences, such as increases in the consumption of non-caloric sweeteners.

The main limitation of this study is the use of observational data to examine changes in purchasing trends, precluding assessment of causality. Additionally, we were unable to disentangle the effects of multiple policy components (ie, labelling, marketing, and school-based restrictions). A second major limitation is that household food purchases do not represent all foods and beverages that Chileans purchase or consume, including categories that probably contain large amounts of high-in foods, such as those eaten away from home or bulk purchases (including unpackaged bread, a top sodium contributor in Chile). We were also limited by missing Kantar data for sales of high-in product categories of energy drinks, salty snacks, chocolate, and candy. If the changes in these omitted foods follow the trends observed in the categories we examined, we might expect even greater changes. Capturing intake from a range of sources to evaluate dietary changes will also be essential for assessing the law's potential impact on health.

Like any observational study, our results varied depending on the model used and underlying data. For example, results could have been underestimated given that we only had data for 18 months before policy implementation. In fact, we estimated a slight downward trend in high-in purchases in the pre-policy period, which does not reflect the longer-term increase in unhealthy food intake that occurred for at least a decade before this. Additionally, we found some variability in estimated differences between the observed results and the counterfactual scenario depending on the model specification and a slight increase in the estimated effect for beverages compared with our previous paper (around 3 calories), although all models consistently found significant declines in overall calories and foods high-in calories, with an increase in foods not-high-in calories.

In conclusion, after phase 1 of the Chilean law of food labelling and advertising was implemented in 2016, we observed important declines in high-in packaged food and beverage purchases that resulted in small but significant declines in purchased calories, sodium, saturated fat, and sugars. More research is needed to understand the overall effect of the law after full implementation in 2019.

Contributors

LST, CC, and BP conceived the study. MB, LST, and MAC devised the analysis plan. MB analysed the data. LST and MB verified and interpreted. LST drafted the initial manuscript. All authors contributed to revision of the manuscript. CC, BP, LST, and MR acquired the study funding. MB, LST, and MAC had access to and verified the underlying data. All authors take responsibility for the decision to submit for publication.

Declaration of interests

We declare no competing interests.

Data sharing

For **Kantar WorldPanel Chile data** see http://kantarworldpanel.com/cl

For more on **Euromonitor** see http://www.portal.euromonitor.com

For the **prespecified analysis plan** see https://osf.io/mj8az/

Data are from Kantar WorldPanel Chile. We are not legally permitted to share the data used for this study, but interested parties can contact Kantar WorldPanel representative Maria Paz Roman (mariapaz.roman@kantar.worldpanel.com) to inquire about accessing this proprietary data. No accession number is needed when requesting data. Additional data come from Euromonitor, which can be accessed only by subscribers; however, many universities and other institutions worldwide have access. The prespecified analysis plan for data is available at Open Science Framework.

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