



## Assessing transnational spillover effects of Mexico's front-of-package nutritional labeling system among Mexican Americans in the US

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### ABSTRACT

**Objective:** In 2020, Mexico implemented innovative front-of-package nutrition warning labels (FoPWLs) for packaged foods to increase the salience and understanding of nutrition information. This study evaluated Mexican Americans' self-reported exposure to Mexican FoPWLs and self-reported effects of FoPWLs on purchasing behavior.

**Methods:** The 2021 International Food Policy Study surveyed online panels of adult Mexican Americans in the US ( $n = 3361$ ) to self-report on buying food at Mexican-oriented stores, noticing Mexican FoPWLs, and being influenced by FoPWLs to purchase less of eight different unhealthy foods (each assessed separately). After recoding the frequency of buying foods in Mexican stores and noticing FoPWLs (i.e., "often" or "very often" vs. less often), logistic models regressed these outcomes on sociodemographics, adjusting for post-stratification weights.

**Results:** Most participants (88.0%) purchased foods in Mexican stores. Of these, 64.1% reported noticing FoPWLs, among whom many reported that FoPWLs influenced them to buy fewer unhealthy foods (range = 32% [snacks like chips] - 44% [colas]). Participants were more likely to buy foods in Mexican stores and notice FoPWLs if they were younger, had  $\geq$  two children at home vs no children (AOR = 1.40, 95%CI = 1.15–1.71; AOR = 1.37, 95%CI = 1.03–1.80, respectively), and more frequently used Spanish (AOR = 1.91, 95%CI = 1.77–2.07; AOR = 1.87, 95%CI = 1.69–2.07). Also, high vs. low education (AOR = 1.51, 95%CI = 1.17–1.94) and higher income adequacy (AOR = 1.37, 95%CI = 1.25–1.51) were positively associated with noticing FoPWLs. Being female and more frequent Spanish use were consistently associated with reporting purchase of fewer unhealthy foods because of FoPWLs.

**Conclusions:** Many Mexican Americans report both exposure to Mexican FoPWLs and reducing purchases of unhealthy foods because of them.

### 1. Introduction

In 2020, Mexico implemented an innovative front-of-package warning label (FoPWL) policy for packaged foods that uses octagonal-shaped warnings (see Supplementary Fig. 1) to identify foods that are high in nutrients of concern – sodium, trans fats, saturated fats, sugar,

and calories (Diario Oficial de la Federación, 2020). Packages display up to five octagons, depending on the number of high nutrients of concern, with healthier foods displaying no FoPWLs. FoPWLs provide simplified and readily accessible information on the nutritional value of foods, enabling consumers to quickly and easily compare options at the point of product selection and consumption. Packaged foods imported from

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Mexico are often sold in Mexican-oriented food stores – both small and large – in the United States (US). Under US and international labeling regulations (United States Federal Government, 2023; Food and Agricultural Organization, 2023), imported packaged foods may keep their original labeling as long as US labeling regulations are fulfilled. Most food products from Mexico can fulfill the US regulations with partial modifications to their labeling (i.e., placing stickers on packaging; see Supplementary Fig. 1), potentially allowing Mexican FoPWLs to enter the US market. However, the reach and effects of Mexican FoPWLs in the US market is unknown. The current study estimated the extent and correlates of self-reported exposure to the Mexican FoPWLs among Mexican Americans, as well as the self-reported impact of FoPWLs on their food purchases.

Qualitative and experimental studies suggest that FoPWLs are more noticeable and more easily understood than Nutrition Facts Tables (NFTs) and other voluntary industry FoP systems, like the Guideline Daily Allowance, among both Mexicans and US Latinos (Vargas-Meza et al., 2019a; Nieto et al., 2019). When comparing Mexican adults and youth with counterparts in other countries, awareness, use, and understanding of food labeling increased more after the 2020 implementation of FoPWLs in Mexico (Hammond et al., 2023; Acton et al., 2023). Hence, the Mexican FoPWLs could influence Mexican Americans to purchase healthier foods, potentially through Mexican-oriented food stores that are often located in communities where people of Mexican heritage reside. Compared to other types of grocery stores, these Mexican stores tend to offer a larger variety of packaged foods imported from Mexico (Palmer and Winham, 2020) and can include a larger variety of affordable and fresher food alternatives (Emond et al., 2012). Furthermore, those who shop in Mexican stores frequently come with children, who often influence adults' food purchases (Calderon et al., 2017).

NFTs have been mandated on the back or side of packaged foods in the US since 1997; however, many consumers, especially those from lower-socioeconomic status (SES) groups, struggle to understand and apply the quantitative information in NFTs (Campos et al., 2011a; Cowburn and Stockley, 2005). NFT use appears lower among Mexican Americans than in the general US population (Ollberding et al., 2011) (i.e., approximately 60% vs 79% (United States Department of Agriculture (USDA) Research Services, 2016)). In the decade following US implementation of mandatory NFTs, people in the US who primarily spoke Spanish had a larger decrease in self-reported NFT use than those who did not (Todd and Variyam, 2008). Lower nutritional knowledge and lower English literacy among Mexican Americans (Haldeman et al., 2000; Britigan et al., 2009) might help explain relatively limited label use. Hence, Spanish language FoPWLs might be more effective among Latinos who predominantly use Spanish.

Mexican American women generally report better diet quality than men (Overcash and Reicks, 2021), and women generally use labels more and make healthier food purchases (Campos et al., 2011b). One study of US Latinos in general found evidence of a segmented cultural assimilation process, wherein income was positively associated with label use among more acculturated Latinos, not among less acculturated Latinos (Wilson et al., 2018). Furthermore, obesity and diet-related chronic diseases may increase food label use to purchase healthier products (Post et al., 2010; Blitstein and Evans, 2006; Loureiro et al., 2012). Nevertheless, one study among Latinos living with diabetes found that only 59% of Latinos with diabetes use NFTs (Kollanor-Samuel et al., 2016), which is lower than the national average of 79% (United States Department of Agriculture (USDA) Research Services, 2016). Similarly, estimates of NFT use are lower among Mexicans with chronic diseases than those without them (Nieto et al., 2020).

The present study of Mexican American adults aimed to estimate self-reported exposure to Mexican FoPWLs and their reported influence on unhealthy food purchases. We evaluate whether key variables associated with label use in prior research (e.g., sociodemographics, Spanish language use, chronic disease status) were associated with purchasing

foods from Mexican-oriented stores, and, among those who purchase foods there, with the frequency they report noticing FoPWLs. We also evaluated the prevalence and characteristics of those who reported buying fewer of a range of unhealthy foods and beverages because of the FoPWLs.

## 2. Methods

### 2.1. Sample

Data were obtained from the 2021 US survey of the International Food Policy Study (IFPS), which is an annual cross-sectional survey using online consumer panels in multiple countries. The IFPS was designed to evaluate general population exposure to, perceptions of, and effects of food policies on dietary intentions and behaviors. In November–December 2021, adults aged 18–100 years old who live in the United States were recruited to participate, with an oversample of self-identified Mexican Americans recruited from Qualtrics and its partner panels. Email and dashboard app invitations with unique survey access links were sent to panelists, with efforts to target recruitment of Latino panelists. During screening, oversample respondents were screened for Mexican ancestry, as well as age, sex, and educational attainment that we used to achieve distributions that approximated those in the general population of Mexican Americans. Potential respondents were screened for eligibility, including quota requirements, and could choose to complete the survey in Spanish or English. Participants provided consent prior to starting the online survey and received remuneration in accordance with their panel's usual incentive structure (e.g., points-based or monetary rewards). Native and bilingual Spanish speakers on the research team reviewed Spanish translations. Study protocols received approvals from the University of Waterloo Research Ethics Committee and the Institutional Review Board at the University of South Carolina.

### 2.2. Measures

#### 2.2.1. Main outcomes

All participants were asked: “In the last month, how often did you purchase food in Mexican stores or markets? Never, Rarely, Sometimes, Often, All the time.” For those who reported any purchases, we adapted an established question on label awareness (Center for Food Safety and Applied Nutrition, 2016), using a “cued recall” approach for enhancing media recall (Niederdeppe, 2014) where we showed an image of a Mexican FoPWL indicating “excess calories” (like the black octagon in Supplementary Fig. 1) and asked “In the last month, how often have you seen this type of food label on Mexican food packages? Never, Rarely, Sometimes, Often, All the time.”

Participants who reported purchases in Mexican stores and that they had noticed FoPWLs rarely or more were then asked: “Have the warning labels (black octagons) changed whether you buy the following packaged products for you or your family?”. Each of the following unhealthy products was queried: cola (Coca-Cola, Pepsi, etc.); soda (Sprite, Orange Crush, etc); diet soda or pop (Coca-Cola Zero, Diet Pepsi, etc.); sweetened fruit drinks (lemonade, iced tea, SunnyD, fruit punch/cocktail, etc.); candy or chocolate bars; snacks such as chips; desserts such as cakes, cookies and ice cream; and sugary cereals. For each product, original responses (Buy less, Buy more, No change) were dichotomized to indicate less frequent purchase (Buy less vs. other options).

#### 2.2.2. Covariates

Demographic information included sex at birth (male, female), age (recoded as: 18 to 29; 30 to 44; 45 to 59; 60 years or older), number of their children under the age of 18 who lived in their household (recoded as: none, one, or two or more), and educational attainment (grouped into: low = high school or lower; medium = associates' degree or vocational/technical certificate; high = university degree or higher). Perceived income adequacy (Litwin and Sapir, 2009) was assessed by

asking “Thinking about your total monthly income, how difficult or easy is it for you to make ends meet? Very difficult, Difficult, Neither difficult nor easy, Easy, Very easy.” Language use was assessed with an 8-item validated scale (e.g., “In general, what language(s) do you read and speak?”) with 5-point Likert responses ranging from 1 (“Only English”) to 5 (“Only Spanish”) (Marín et al., 1987). As reliability was high (alpha = 0.96), responses across questions were averaged.

Participants' role in household food purchases and, therefore, potential for more exposure to nutrition labels, was assessed by asking “How much of the food shopping do you do in your household?” (recoded as: “Most of the shopping” or “Shared equally”; “Less shopping than others” or “None of the shopping”) Body mass index (BMI) was estimated from self-reported weight and height and classified as underweight (<18.5), normal (18.5–24.99), overweight (25–29.99), obese (30–47.83) kg/m (United States Federal Government, 2023), or missing.

Finally, we used a standard checklist from the Behavioral Risk Factor Surveillance System (Centers for Disease Control and Prevention, 2016), asking participants if a health professional had ever told them they had each of the following diet-related chronic diseases: high blood pressure; a heart attack or myocardial infarction; angina or coronary heart disease; diabetes or high blood sugar; or high blood cholesterol. We summed and recoded the number of diseases reported to: “none,” “one,” or “two or more” to have adequate sample size in each category.

### 2.3. Analysis

The sample comprised 3361 Mexican Americans who completed the survey and passed data quality checks. The study participation rate (sample/total eligible invites) was 10.1%, and the cooperation rate (sample/eligible invites who accessed the survey link) was 65.3%. Post-

**Table 1**  
Analytic samples of Mexican American adults in the United States, 2021.

Sample characteristics	Entire sample (n = 3361)		Subsample: Purchased food in Mexican stores last month (n = 2957)		Subsample: Noticed FoPWLs in last month (n = 1917)		
	Unweighted %	Weighted %	Unweighted %	Weighted %	Unweighted %	Weighted %	
Sex	Male	44.4	49.9	45.1	50.2	48.4	53.5
	Female	55.6	50.1	54.9	49.8	51.6	46.5
	18–29 years old	33.6	34.4	35.2	35.9	39.2	39.7
	30–44 years old	36.4	28.9	37.2	29.8	39.4	32.1
Age	45–59 years old	24.6	30.3	23.5	29.5	18.8	24.9
	60+ years old	5.4	6.5	4.1	4.8	2.7	3.3
	Low (≤high school)	51.5	76.3	51.0	75.6	47.9	72.7
Education	Medium	24.3	7.4	23.8	7.3	23.5	7.6
	High (≥university)	24.2	16.3	25.2	17.1	28.5	19.7
	Very difficult	11.4	12.2	10.6	11.5	8.9	9.5
	Difficult	22.0	22.6	22.0	22.6	20.8	21.7
Perceived income adequacy	Neither	38.9	39.8	39.5	40.4	41.1	42.0
	Easy	18.1	16.8	18.6	19.0	19.8	18.3
	Very easy	9.5	8.7	9.4	8.6	9.5	8.6
Children in household	None	54.8	58.8	53.3	57.2	50.0	53.6
	One	20.1	18.8	20.3	18.9	21.1	19.8
	Two or more	25.1	22.5	26.4	23.9	28.9	26.7
	Underweight	2.4	2.4	2.5	2.5	2.9	2.9
BMI	Normal weight	27.6	25.5	28.3	26.1	30.7	28.6
	Overweight	27.3	27.1	27.4	27.3	26.9	27.2
	Obese	29.4	31.5	28.5	30.7	25.0	27.1
	Missing	13.4	13.5	13.2	13.4	14.5	14.2
	None	62.2	61.9	63.2	63.1	64.3	65.0
Diet-related chronic diseases	One	20.5	19.9	20.1	19.4	19.7	18.6
	Two or more	17.3	18.2	16.7	17.5	16.0	16.4
	None to minor	11.7	14.2	11.3	13.7	11.4	14.3
Shopping role for household	Equal to other(s)	23.3	24.2	23.7	24.5	24.6	25.3
	Most	65.0	61.6	65.0	61.8	64.0	60.4
Spanish language use <sup>1</sup> (mean)		2.39	2.35	2.49	2.47	2.67	2.67
	California	29.1	32.9	30.2	34.3	28.3	31.9
	Texas	26.7	25.9	25.4	24.8	25.1	24.9
	West	17.3	20.1	16.9	19.4	16.2	18.9
State of residence <sup>2</sup>	Midwest	12.5	9.8	12.7	9.9	12.7	10.2
	Southeast	10.4	8.6	10.4	8.7	11.8	10.1
	Northeast	4.1	2.7	4.4	2.9	5.8	4.0
	Never	11.3	12.0	N/A	N/A	N/A	N/A
	Rarely	16.6	16.5	18.7	18.7	12.2	12.1
	Sometimes	35.4	36.1	40.0	41.0	40.6	42.0
	Often	26.8	25.5	30.3	28.9	34.5	32.9
Frequency of shopping in Mexican food stores, last month	All the time	9.8	10.0	11.0	11.3	12.6	12.9
	Never			33.4	35.9	N/A	N/A
	Rarely			18.4	18.1	27.6	28.3
	Sometimes			25.7	25.8	38.7	40.3
	Often			13.9	12.4	20.9	19.4
Frequency of noticing FoPWLs, last month	All the time			8.6	7.8	12.9	12.1

<sup>1</sup> Range = 1–5 (average of 8 items) for frequency of language use (1 = English only – 5 = Spanish only).

<sup>2</sup> West = Alaska, Arizona, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming; Midwest = Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin; Southeast = Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Virginia, West Virginia; Northeast = Connecticut, Delaware, District of Columbia, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island.

stratification sample weights were developed based on distributions of the Mexican American population by category combinations of sex, age (18–29; 30–44; 45+), educational attainment ( $\leq$ high school; Associate's degree;  $\geq$  University degree), and region (West, South, Northeast/Midwest [collapsed due to small sample]), as reflected in the 2021 American Community Survey Public Use Microdata Sample. Weights for each sexXageXeducationXregion combination reflect 2021 estimates for Mexican Americans in each subgroup and were re-scaled to sum to the actual sample size (weight range = 0.166–3.112). Weighted and unweighted descriptive statistics are reported for outcomes and covariates, and all models were adjusted for weights.

Ordinal regression models were estimated for the outcomes of frequency of purchasing food at Mexican stores and noticing FoPWLS; however, these models violated the proportional odds assumption, even after combining response options to evaluate different 3- and 4-level specifications for the outcomes. Hence, we re-coded these outcomes as binary (i.e., "Often" or "All the time" vs other responses = reference). For all outcomes, including separate models for each food product category when assessing "Buying less" (reference = not buying less) due to the FoPWLS, bivariate and adjusted logistic regression models were estimated, with adjusted models including all covariates (see above). Because Mexican FoPWLS are Spanish and prior research found that language use modified the association between income and nutrition label use (Wilson et al., 2018), we estimated additional adjusted models for each outcome that included an interaction between Spanish language use and perceived income adequacy. When this interaction was significant, we estimated stratified models for three Spanish language use levels ( $>3$ : more Spanish than English;  $>2-3$ : roughly equal English and Spanish use;  $\leq 2$ : mostly English use) to assess the association and plot predicted probabilities between perceived income adequacy and outcomes. All analysis were run in SAS version 9.4.

### 3. Results

Table 1 shows the characteristics of each analytic sample. Most participants (weighted = 88.0%) reported purchasing foods at Mexican stores in the prior month, among whom nearly two-thirds (weighted = 64.1%) also reported noticing Mexican FoPWLS.

#### 3.1. Frequent shopping in Mexican stores

About one-third of the sample (weighted = 35.4%) reported frequently purchasing foods (i.e., "Often" or "All the time") in Mexican stores. In adjusted logistic regression models (Table 2), those with higher perceived income adequacy or two or more children (vs none) were more likely to frequently buy foods in Mexican stores, whereas those who were older or used English more frequently were less likely to do so. The interaction between language use and income adequacy was statistically significant (AOR = 1.16, 95%CI = 1.14–1.18;  $p < 0.001$ ). In the stratified analysis by language use (results available on request), the positive, independent association between perceived income adequacy and frequently buying foods in Mexican stores was only found for those with roughly equal Spanish and English use (AOR = 1.15, 95%CI = 1.03–1.30), with predicted probability plots indicating this was driven by the high frequency among those with highest income adequacy (See Appendix, Fig. 2a).

#### 3.2. Frequent noticing FoPWLS

About one-fifth (weighted = 20%) of participants who shopped in Mexican stores self-reported frequently noticing (i.e., "Often" or "Very often") FoPWLS. Results from adjusted models (Table 3) indicated that having high educational attainment (vs low), higher income adequacy, having any children at home (one or  $\geq 2$  vs none), two or more diet-related chronic diseases (vs none), and doing most of the household shopping (vs none or some) were positively associated with frequently

**Table 2**

Prevalence and correlates of Mexican American adults who frequently purchased food<sup>1</sup> in Mexican-oriented stores in the prior month, 2021.

Characteristics	% purchased "often"/"all the time"	Bivariate models		Adjusted model	
		OR	[95% CI]	AOR	[95% CI]
Sex (ref = male)	35.4				
Female	35.4	1.01	[0.88, 1.17]	0.95	[0.81, 1.12]
Age (ref = 18–29 years old)	40.5				
30–44 years old	39.8	0.99	[0.83, 1.18]	0.80*	[0.65, 0.97]
45–59 years old	29.8	0.65***	[0.54, 0.78]	0.63***	[0.52, 0.79]
60+ years old	15.3	0.27***	[0.18, 0.40]	0.31***	[0.20, 0.47]
Education (ref = low)	34.7				
Medium	35.5	1.03	[0.78, 1.36]	1.04	[0.78, 1.39]
High	38.9	1.21	[1.00, 1.47]	1.02	[0.82, 1.26]
Income Adequacy <sup>2</sup>		1.05	[0.99, 1.12]	1.09*	[1.02, 1.18]
Children at home (ref = none)	30.5				
One	38.4	1.44***	[1.19, 1.73]	1.21	[0.98, 1.48]
Two or more	45.5	1.94***	[1.63, 2.31]	1.40***	[1.15, 1.71]
BMI (ref = Normal weight)	36.6				
Underweight	39.4	1.13	[0.71, 1.8]	1.07	[0.65, 1.75]
Overweight	33.6	0.87	[0.71, 1.06]	0.89	[0.72, 1.10]
Obese	32.1	0.83	[0.68, 1.00]	0.97	[0.78, 1.20]
Missing	44.0	1.42**	[1.12, 1.81]	1.02	[0.78, 1.33]
Diet-related chronic diseases (ref = none)	36.2				
One	34.7	0.96	[0.80, 1.15]	1.13	[0.92, 1.38]
Two or more	33.5	0.92	[0.76, 1.11]	1.19	[0.95, 1.50]
Shopper role (ref = none/some)	32.2				
Share equally with other(s)	33.6	1.11	[0.87, 1.43]	1.05	[0.80, 1.37]
Most	37.0	1.28*	[1.03, 1.60]	1.24	[0.97, 1.59]
Spanish language use <sup>3</sup>		2.00***	[1.86, 2.16]	1.91***	[1.77, 2.07]

CI = confidence interval. \*pvalue<0.05, \*\*pvalue<0.01, \*\*\*pvalue<0.001.

<sup>1</sup> Binary outcome of "often" or "all the time" vs. less often = 35.4%; the original distribution is shown in Table 1; entire sample (n = 3361).

<sup>2</sup> Range = 1–5 for adequacy of household monthly income for making ends meet (1 = very difficult - 5 = very easy).

<sup>3</sup> Range = 1–5 (average of 8 items) for frequency of language use (1 = English only - 5 = Spanish only).

noticing FoPWLS; older age and more frequent English language use were inversely associated. The interaction between language use and income adequacy was not statistically significant (AOR = 1.08, 95%CI = 0.98–1.18).

#### 3.3. Influence of warning labels on food purchase

Of those who reported noticing FoPWLS, the percentage who reported that FoPWLS influenced them to buy fewer unhealthy foods or beverages ranged from 32% for snacks like chips to 44% for colas



**Table 3**  
Prevalence and correlates of Mexican American adults who frequently noticed front-of-package warning labels<sup>1</sup> in the last month, 2021.

Characteristics	% who notice "often"/ "very often"	Bivariate model		Adjusted model	
		OR	[95% CI]	OR	[95% CI]
Sex (ref = male)	20.0				
Female	20.3	1.03	[0.86, 1.24]	0.96	[0.78, 1.18]
Age (ref = 18–29 years old)	23.6				
30–44 years old	23.6	0.98	[0.79, 1.22]	0.63***	[0.49, 0.81]
45–59 years old	15.0	0.57***	[0.44, 0.72]	0.42***	[0.32, 0.56]
60+ years old	5.1	0.17***	[0.08, 0.37]	0.15***	[0.07, 0.33]
Education (ref = low)	18.0				
Medium	20.9	1.17	[0.82, 1.66]	1.16	[0.79, 1.69]
High	29.6	1.88***	[1.5, 2.35]	1.51**	[1.17, 1.94]
Income Adequacy <sup>2</sup>		1.29***	[1.19, 1.41]	1.37***	[1.25, 1.51]
Children at home (ref = none)	14.6				
One	23.8	1.80***	[1.41, 2.29]	1.55**	[1.18, 2.03]
Two or more	23.0	2.49***	[2.01, 3.08]	1.91***	[1.50, 2.45]
BMI (ref = Normal weight)	22.2				
Underweight	20.8	0.90	[0.50, 1.63]	0.86	[0.46, 1.62]
Overweight	19.3	0.81	[0.63, 1.04]	0.92	[0.70, 1.20]
Obese	16.7	0.70	[0.54, 0.90]	0.95	[0.72, 1.25]
Missing	26.1	1.26	[0.94, 1.68]	0.94	[0.68, 1.30]
Diet-related chronic diseases (ref = none)	20.4				
One	19.2	0.93	[0.73, 1.19]	1.12	[0.86, 1.45]
Two or more	20.6	1.02	[0.79, 1.30]	1.37*	[1.03, 1.80]
Shopper role (ref = none/some)	14.9				
Share equally with other(s)	16.9	1.13	[0.80, 1.61]	0.99	[0.68, 1.43]
Most	22.6	1.65**	[1.21, 2.24]	1.46*	[1.04, 2.04]
Spanish language use <sup>3</sup>		1.88***	[1.71, 2.06]	1.87***	[1.69, 2.07]

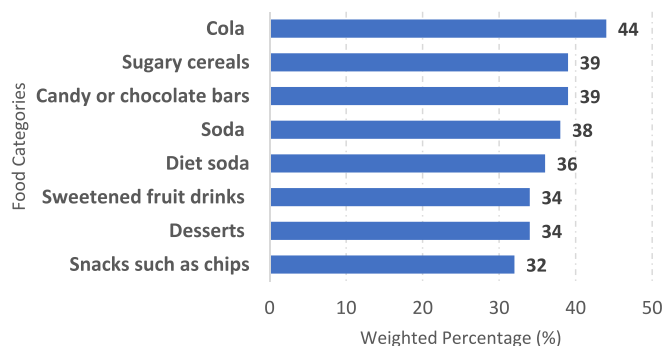
CI = confidence interval. \*pvalue<0.05, \*\*pvalue<0.01, \*\*\*pvalue<0.001.

<sup>1</sup> Binary outcome of "often" or "all the time" vs. other responses; the original distribution is shown in Table 1; analytic sample is those who purchased any foods in Mexican stores in the prior month (n = 2957).

<sup>2</sup> Range = 1–5 for adequacy of household monthly income for making ends meet (1 = very difficult - 5 = very easy).

<sup>3</sup> Range = 1–5 (average of 8 items) for frequency of language use (1 = English only - 5 = Spanish only).

(Fig. 1). With the exception of cola and candies, females were more likely than males to report buying less across all food categories assessed because of the FoPWLs (AOR range = 1.27 [soda] - 1.47 [sugary cereal & diet soda]). Except for diet soda, those who more frequently used Spanish were more likely to report buying fewer foods because of the FoPWLs (AOR range = 1.22 [sweetened fruit drinks] - 1.35 [cola & diet soda]). Otherwise, there were no consistent, statistically significant differences across levels of education, income, BMI, number of diet-related chronic diseases, or household shopper role (see



**Fig. 1.** Percentage of Mexican American adults<sup>1</sup> who reported buying less of different unhealthy foods and drinks due to Mexican front of package warning labels, 2021.

<sup>1</sup>Analytic sample = people who purchased foods at Mexican stores and noticed front-of-package warning labels (n = 1917).

Supplementary Tables).

For three products, the interaction between language use and perceived income adequacy were statistically significant: snacks like chips (AOR = 0.86, 95%CI 0.87–0.95; p = 0.002); desserts (AOR = 0.86, 95%CI 0.87–0.95; p = 0.002), and sugary cereals (AOR = 0.91, 95%CI = 0.83–1.00, p = 0.04). In predicted probability plots (See Appendix, Figs. 2b-d) and stratified adjusted models, the coefficients for income adequacy across all three outcomes indicated a gradient from inverse associations among those who mostly use Spanish to somewhat positive associations among those who mostly use English. Statistically significant findings were limited to an inverse association between income adequacy and self-reported buying fewer snacks among participants who mostly use Spanish (AOR = 0.77, 95%CI = 0.63–0.95) and a positive association between income adequacy and self-reported buying less sugary cereal among participants who mostly use English (AOR = 1.22, 95%CI = 1.00–1.48).

#### 4. Discussion

The vast majority of Mexican Americans we surveyed had purchased foods in Mexican stores (88.0%), of whom most had noticed packaged foods with the Mexican FoPWLs (64.1%), indicating that the Mexican policy has spilled over into the US market and has an opportunity to influence people who shop in Mexican-oriented stores. Furthermore, many participants who noticed the FoPWLs reported buying fewer of the unhealthy packaged foods on which Mexican FoPWLs are commonly present (range = 32% for snacks to 44% for colas). This suggests that the Mexican policy has had a desirable effect on a US population subgroup with high rates of diet-related obesity (Ford et al., 2014; Morales et al., 2014). This positive policy spillover effect is due, in part, to international trade agreements that aim to reduce unnecessary burdens to commerce, such as requiring food packaging specific to each country. Study authors have confirmed that Mexican products with country-of-origin packaging are sold in Mexican stores, and that FoPWLs remain visible even after alteration of packaging to comply with US regulations (e.g., stickers with US nutrition labels and ingredients on packaging; Supplementary Fig. 1).

The percentage of Mexican Americans in our sample who reported buying foods from Mexican stores (88.0%) is comparable but somewhat higher than that found in a previous study (77.3%) in a small convenience sample of Latinos (n = 45) in the US Midwest (Palmer and Winham, 2020). Our sample was much larger and drew participants from across the US, likely including established Mexican American enclaves that are particularly likely to have Mexican-oriented stores for shopping. As expected, we found that participants who more frequently use Spanish were more likely to purchase foods at Mexican stores. However, the positive association we found between income adequacy

and frequent purchasing at Mexican stores was unexpected, since other research found that lower income populations rely more on Mexican stores, likely due to their relatively cheap prices (Emond et al., 2012). The positive association between income adequacy and frequent purchasing from Mexican stores was limited to the subpopulation that used English and Spanish more equally. The reasons for this pattern of association are unclear but results overall suggest that nutrition interventions that aim to reach low-income and older Mexican Americans through Mexican stores should assess their clientele, especially if these populations are likely to purchase foods from stores with even lower prices (e.g., box stores).

Attention toward nutrition labels is a critical step toward processing their content, and we found that participants who were younger, had high education (vs low), and higher income adequacy were more likely to frequently notice FoPWLs, as has been found for attention to NFTs (Bhawra et al., 2023). Younger people may be more likely to attend to novel information on packaging due to their food and brand preferences being less well-established. The Mexican FoPWLs were specifically designed to be easily understood among less literate populations; hence, low-literacy FoPWLs may not be able to completely offset disparities. It is important to note, however, that among those who noticed FoPWLs, education and income adequacy were mostly unassociated with buying fewer unhealthy products because of FoPWLs. Furthermore, these patterns of association may be due, in part, to variation in the availability of foods with FoPWLs across Mexican stores. Future research should examine which Mexican products tend to have FoPWLs and evaluate consumers' exposures to these products to further clarify their effects. Indeed, prior qualitative and experimental research has found that FoPWLs capture attention and engage consumers more than NFTs and other labeling systems (Vargas-Meza et al., 2019a; Nieto et al., 2019).

The positive relationship we found between more frequent Spanish language use and frequently noticing FoPWLs was expected given that Mexican FoPWLs are in Spanish. We also found that those who used Spanish more often were more likely to report that the FoPWLs influenced them to buy less of all unhealthy products queried except diet soda. For three products (i.e., snacks, desserts, sugary cereals), we found evidence that language use modified the association between perceived income adequacy and reported purchasing fewer of these unhealthy foods, such that positive associations were limited to those who mostly used English (statistical significance reached only for sugary cereal), and inverse associations were found for those who mostly used Spanish (statistical significance reached only for snacks). These results align with prior research showing that the positive association between income and nutrition label use was limited to Latinos who spoke English at home (Wilson et al., 2018). Our assessment contrasts with this research, however, which was focused on English language labels, as we report on Spanish language FoPWLs, and perhaps because of this, we found no associations with perceived income adequacy or education. As the US Latino population continues to grow, regulators may consider requiring labels with both Spanish and English, as is mandated for French and English in Canada.

A few findings are noteworthy regarding the reported influence of FoPWLs on reducing purchases of unhealthy foods. First, a substantial percentage of Mexican Americans who noticed FoPWLs in Mexican stores, especially females, reported that the FoPWLs influenced them to buy fewer unhealthy foods and beverages. The greater reported impact among women is consistent with other research on stronger labeling effects among females (Campos et al., 2011a; Campos et al., 2011b; Bhawra et al., 2023). Second, the self-reported effects of Mexican FoPWLs on purchasing fewer unhealthy products was relatively consistent across age groups, education attainment, income adequacy levels, BMI, and having diet-related chronic diseases. This pattern of findings is consistent with the intent of the Mexican FoPWLs: to be understood and used equally across sociodemographic groups (Nieto et al., 2019; Acton et al., 2023; Vargas-Meza et al., 2019b). As such, US implementation of well-designed FoPWLs that capture consumers'

attention could have an overall positive effect on US population nutrition without exacerbating nutrition-related disparities. Research with a range of disadvantaged groups would be necessary to help ensure equitable policy effects across US subpopulations.

The generalizability of results from our study is potentially limited by our sampling method, which, despite high internet use among US Latinos (95%) (Pew Research Center, 2021), resulted in fewer Mexican Americans with relatively low educational attainment than in the general population. The mostly null effect of educational attainment on our study outcomes suggests that this was not a serious limitation. Furthermore, the US regions where participants lived, including more than half in California and Texas, are similar to 2021 census estimates. Nevertheless, our integration of weights may not have fully accounted for potential selection biases. Generalizability may also be compromised by our relatively low participation rate, though this rate is consistent with online surveys. Recall biases and social desirability may have resulted in overestimates for self-reported outcomes, such as purchasing less unhealthy foods due to the FoPWLs. Research on store receipts and household purchases is needed to solidify understanding of policy effects on purchases of different types of products, as has been done in Chile (Taillie et al., 2020).

## 5. Conclusions

Our study of Mexican Americans found that many report being exposed to and influenced by FoPWLs on food and beverage products from Mexico, thereby contributing to the growing body of evidence that FoPWLs are more likely to be effective than NFTs across a variety of populations (Vargas-Meza et al., 2019a; Nieto et al., 2019; Hammond et al., 2023; Acton et al., 2023). Health promotion and nutrition counseling professionals should be aware that many Mexican Americans (and potentially others who shop in Mexican-oriented stores) may be exposed to Mexican FoPWLs – interventions that target lower SES subgroups could highlight this source of simplified nutrition information that people can use to support healthy eating. The influence of FoPWLs on purchasing fewer unhealthy products was relatively consistent across population subgroups, which aligns with the FoPWL objective of being understood and used equally across sociodemographic groups. Lastly, this study highlights how globalization may facilitate spillover of labeling policies from one country to positively influence another country's population.

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## CRediT authorship contribution statement

**James F. Thrasher:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **Victor Eduardo Villalobos-Daniel:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Dai Fang:** Writing – review & editing, Methodology, Formal analysis. **Claudia Nieto:** Writing – review & editing, Methodology. **Christine M. White:** Writing – review & editing, Project administration. **Gabriela Armendariz:**

Writing – review & editing, Project administration. **Alejandra Jáuregui:** Writing – review & editing, Funding acquisition, Conceptualization. **David Hammond:** Writing – review & editing, Resources, Methodology, Funding acquisition. **Rachel E. Davis:** Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Conceptualization.

### Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

David Hammond has provided paid expert testimony on behalf of public health authorities in response to challenges from the food and beverage industry. Other authors have no conflicts of interest to declare.

### Data availability

Data will be made available on request.

### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ypmed.2024.107855>.

### References

- Acton, R.B.R.V., Adams, J., Bhawra, J., Cameron, A.J., Contreras-Manzano, A., Davis, R. E., Jáuregui, A., Sacks, G., Thrasher, J.F., Vanderlee, L., White, C.M., Hammond, D., 2023. Awareness, use and understanding of nutrition labels among adults from five countries: findings from the 2018–2020 International Food Policy Study. *Appetite*. 180, e106311.
- Bhawra, J., Kirkpatrick, S., Hall, M., et al., 2023. A five-country study of front- and back-of-package nutrition label awareness and use: patterns and correlates from the 2018 international food policy study. *Public Health Nutr.* 26 (1), 275–286.
- Blitstein, J.L., Evans, W.D., 2006. Use of nutrition facts panels among adults who make household food purchasing decisions. *J. Nutr. Educ. Behav.* 38 (6), 360–364.
- Britigan, D.H., Murnan, J., Rojas-Guyler, L., 2009. A qualitative study examining Latino functional health literacy levels and sources of health information. *J. Community Health* 34, 222–230.
- Calderon, J., Ayala, G.X., Elder, J.P., et al., 2017. What happens when parents and children go grocery shopping? An observational study of Latino dyads in Southern California, USA. *Health Educ. Behav.* 44 (1), 5–12.
- Campos, S., Doxey, J., Hammond, D., 2011a. Nutrition labels on pre-packaged foods: a systematic review. *Public Health Nutr.* 14 (08), 1496.
- Campos, S., Doxey, J., Hammond, D., 2011b. Nutrition labels on pre-packaged foods: a systematic review. *J. Public Health Nutr.* 18 (1–11).
- Center for Food Safety and Applied Nutrition, 2016. 2014 Food and Drug Association Health and Diet Survey. United States Food and Drug Administration.
- Centers for Disease Control and Prevention, 2016. 2017 Behavioral Risk Factor Surveillance System Questionnaire (BRFSSQ). [https://wwwn.cdc.gov/nchs/data/naahes/2015-2016/questionnaires/WHQ\\_1.pdf](https://wwwn.cdc.gov/nchs/data/naahes/2015-2016/questionnaires/WHQ_1.pdf). Accessed August 7, 2020.
- Cowburn, G., Stockley, L., 2005. Consumer understanding and use of nutrition labelling: a systematic review. *Public Health Nutr.* 8 (01), 21.
- Diario Oficial de la Federación, 2020. MODIFICACIÓN a la Norma Oficial Mexicana NOM-051-SCFI/SSA1–2010, Especificaciones generales de etiquetado para alimentos y bebidas no alcohólicas preenvasados-Información comercial y sanitaria [Modification of Rules: General specifications for labeling of packaged foods and non-alcoholic beverages - Commercial and Sanitary Information]. In: Mexico Go.
- Emond, J., Madanat, H., Ayala, G., 2012. Do Latino and non-Latino grocery stores differ in the availability and affordability of healthy food items in a low-income, metropolitan region? *Public Health Nutr.* 15 (2), 360–369.
- Food and Agricultural Organization, 2023. Package and Labeling Regulations, CODEX-Alimentarius. United Nations.
- Ford, E.S., Maynard, L.M., Li, C., 2014. Trends in mean waist circumference and abdominal obesity among US adults, 1999–2012. *JAMA*. 312 (11), 1151–1153.
- Haldeman, L., Pérez-Escamilla, R., Ferris, A.M., et al., 2000. Development of a color-coded bilingual food label for low-literacy Latino caretakers. *J. Nutr. Educ.* 32 (3), 152–160.
- Hammond, D.A.R., Rynard, V.L., White, C.M., Vanderlee, L., Bhawra, J., Reyes, M., Jáuregui, A., Adams, J., Roberto, C.A., Sacks, G., Thrasher, J.F., 2023. Awareness, use and understanding of nutrition labels among children and youth from six countries: findings from the 2019–2020 International Food Policy Study. *Int. J. Behav. Nutr. Phys. Act.* 20 (1), 55.
- Kollannoor-Samuel, G.S.F., Segura-Pérez, S., Chhabra, J., Vega-López, S., Pérez-Escamilla, R., 2016. Effects of food label use on diet quality and glycemic control among latinos with type 2 diabetes in a community health worker-supported intervention. *Am. J. Public Health* 106 (6), 1059–1066.
- Litwin, H., Sapir, E.V., 2009. Perceived income adequacy among older adults in 12 countries: findings from the survey of health, ageing, and retirement in Europe. *Gerontologist* 49 (3), 397–406.
- Loureiro, M.L., Yen, S.T., Nayga, J., Rodolfo, M., 2012. The effects of nutritional labels on obesity. *Agric. Econ.* 43 (3), 333–342.
- Marín, G.S.F., Marín, B.V., Otero-Sabogal, R., Perez-Stable, E.J., 1987. Development of a short acculturation scale for Hispanics. *Hisp. J. Behav. Sci.* 9, 183–205.
- Morales, L.S., Flores, Y.N., Leng, M., Sportiche, N., Gallegos-Carrillo, K., Salmeron, J., 2014. Risk factors for cardiovascular disease among Mexican-American adults in the United States and Mexico: a comparative study. *Salud Publica Mex.* 56 (2), 197–205.
- Niederdeppe, J., 2014. Conceptual, empirical, and practical issues in developing valid measures of media campaign exposure. *Commun. Methods Meas.* 8 (2), 138–161.
- Nieto, C., Jáuregui, A., Contreras-Manzano, A., et al., 2019. Understanding and use of food labeling systems among whites and Latinos in the United States and among Mexicans: results from the international food policy study, 2017. *Int. J. Behav. Nutr. Phys. Act.* 16 (1), 87.
- Nieto, C., Tolentino-Mayo, L., Monterrubio-Flores, E., et al., 2020. Nutrition label use is related to chronic conditions among Mexicans: data from the Mexican National Health and nutrition survey 2016. *J. Acad. Nutr. Diet.* 120 (5), 804–814.
- Ollberding, N.J., Wolf, R.L., Contento, I., 2011. Food label use and its relation to dietary intake among US adults. *JAmDietAssoc.* 111 (5), S47.
- Overcash, F., Reicks, M., 2021. Diet quality and eating practices among Hispanic/Latino men and women: NHANES 2011–2016. *Int. J. Environ. Res. Public Health* 18 (3).
- Palmer, S.M., Winham, D.M., 2020. Midwest consumer shopping habits, nutrition knowledge, and Latino tienda use. *Health Behav. Pol. Rev.* 7 (2), 79–91.
- Pew Research Center, 2021. Internet/Broadband Fact Sheet: Who Uses the Internet. <https://www.pewresearch.org/internet/fact-sheet/internet-broadband/?tabid=tab-d5edf003-5858-4269-89c5-f2889ecf7951>. Accessed August 24, 2023.
- Post, R.E., Mainous III, A.G., Diaz, V.A., Matheson, E.M., Everett, C.J., 2010. Use of the nutrition facts label in chronic disease management: results from the National Health and nutrition examination survey. *JAmDietAssoc.* 110 (4), 628–632.
- Taillie, L., Reyes, M., Colchero, M., Popkin, B., Corvalán, C., 2020. An evaluation of Chile's law of food labeling and advertising on sugar-sweetened beverage purchases from 2015 to 2017: a before-and-after study. *PLoS Med.* 17 (2), e1003015.
- Todd, J.E., Varyiam, J.N., 2008. The Decline in Consumer Use of Food Nutrition Labels, 1995–2006. United States Department of Agriculture, Economic Research Service, p. 56466.
- United States Department of Agriculture (USDA) Research Services, 2016. National Household Food Acquisition and Purchase Survey (FoodAPS). USDA.
- United States Federal Government, 2023. Code of Federal Regulations, 21 CFR Part 101. Archives N.
- Vargas-Meza, J., Jáuregui, A., Pacheco-Miranda, S., Contreras-Manzano, A., Barquera, S., 2019a. Front-of-pack nutritional labels: understanding by low- and middle-income Mexican consumers. *PLoS One* 14 (11), e0225268.
- Vargas-Meza, J., Jáuregui, A., Contreras-Manzano, A., Nieto, C., Barquera, S., 2019b. Acceptability and understanding of front-of-pack nutritional labels: an experimental study in Mexican consumers. *BMC Public Health* 19 (1), 1751.
- Wilson, M.D., Ramírez, A.S., Arsenault, J.E., Miller, L.M.S., 2018. Nutrition label use and its association with dietary quality among Latinos: the roles of poverty and acculturation. *J. Nutr. Educ. Behav.* 50 (9), 876–887.